

## TITLE OF THE INVENTION

Content-Duplication Management System, Apparatus and Method,  
Playback Apparatus and Method, and Computer Program

5        This application is based on an application  
no.2002-249215 filed in Japan, the content of which is hereby  
incorporated by reference.

## BACKGROUND OF THE INVENTION

### 10    1. Field of the Invention

The present invention relates to a content-duplication  
management system that manages duplication of contents  
requiring copyright protection.

### 15    2. Related Art

In recent years, the digitalization and circulation of  
movies, music and so forth as digital contents has become  
prevalent.

Digital contents have the quality of being easily  
20    duplicated without deterioration in quality.

Technology for preventing the unrestricted duplication  
of contents is disclosed in unexamined Japanese patent  
application no. 2000-357213.

In unexamined Japanese patent application no.

2000-357213, a recording apparatus, which is content duplication source, manages a remaining number of duplications permitted of a content. Mutual authentication is conducted between the recording apparatus and a recording  
5 medium to which the content is to be duplicated, and if mutual authentication is successful, the recording apparatus duplicates the content to the recording medium within a range of the remaining number, and subtracts "1" from the remaining number. Also, when a duplicated content is deleted from the  
10 recording medium, the recording apparatus adds "1" to the remaining number of the content.

As such, the technology disclosed in unexamined Japanese patent application no. 2000-357213 allows for copyright protection by preventing the unrestricted  
15 diffusion of contents, using mutual authentication and management of a remaining number.

#### SUMMARY OF THE INVENTION

However, because the above duplication management  
20 technology does not anticipate the use of a network that includes a home network, the following problems arise.

When the above duplication management technology is applied in a configuration in which devices that use contents are connected via a network, the stiffening of restrictions

applied to content duplication means that while content duplication restrictions on devices connected outside the home network become stiffer, thus allowing for copyright protection, content duplication restrictions are also  
5 stiffened for devices connected within the home network, over which private content usage is conducted, and convenience for home network users is thus compromised.

On the other hand, although relaxing duplication restrictions means that convenience is improved with respect  
10 to home use, the down side is that duplicated contents will find their way to devices outside of the home.

In view of the above problems, the present invention aims to provide a content-duplication management system that allows convenient content duplication for users, while  
15 protecting the rights of copyright holders, when a network that includes a home network is used.

(1) A content-duplication management apparatus of the present invention manages duplication and deletion of a content with respect to a playback apparatus connected to  
20 a network, based on requests acquired from the playback apparatus, and includes: a group judging unit operable to judge whether the playback apparatus belongs to a predetermined group; a holding unit operable to hold an in-group remaining number and an out-group remaining number,

the in-group remaining number being a remaining number of duplications of the content permitted of apparatuses belonging to the group, and the out-group remaining number being a remaining number of duplications of the content permitted of apparatuses not belonging to the group; and a management unit operable, in response to a request acquired from the playback apparatus, to (i) reply in the affirmative and update the in-group remaining number or reply in the negative, based on the in-group remaining number, when the playback apparatus is judged to belong to the group, and (ii) reply in the affirmative and update the out-group remaining number or reply in the negative, based on the out-group remaining number, when the playback apparatus is judged to not belong to the group.

According to this structure, the number of duplications to in-group and out-group apparatuses is managed separately, thus allowing for copyright protection by stiffening restrictions on content duplication to out-group apparatuses, and for improvements in user convenience by relaxing restrictions on content duplication to in-group apparatuses.

(2) Also, the request may be a duplication request, and the management unit may, in response to the duplication request, (i) reply in the affirmative and subtract "1" from the in-group remaining number if the in-group remaining



number is not "0", and reply in the negative if the in-group remaining number is "0", when the playback apparatus is judged to belong to the group, and (ii) reply in the affirmative and subtract "1" from the out-group remaining  
5 number if the out-group remaining number is not "0", and reply in the negative if the out-group remaining number is "0", when the playback apparatus is judged to not belong to the group.

According to this structure, the number of duplications  
10 to in-group and out-group apparatuses is managed separately, thus allowing for copyright protection by stiffening restrictions on content duplication to out-group apparatuses, and for improvements in user convenience by relaxing restrictions on content duplication to in-group apparatuses.

15 (3) Also, the request may be a deletion request, and the management unit may, in response to the deletion request, (i) reply in the affirmative and add "1" to the in-group remaining number when the playback apparatus is judged to belong to the group, and (ii) reply in the affirmative and  
20 add "1" to the out-group remaining number when the playback apparatus is judged to not belong to the group.

According to this structure, the number of duplications to in-group and out-group apparatuses is managed separately, thus allowing for copyright protection by stiffening

restrictions on content duplication to out-group apparatuses,  
and for improvements in user convenience by relaxing  
restrictions on content duplication to in-group apparatuses:

(4) Also, the request may include start information  
5 indicating a start time of duplication or deletion of the  
content, the content-duplication management apparatus may  
further include a time management unit that includes a clock  
and is operable, when the start time is shown by the clock,  
to output an operation instruction to the management unit,  
10 and the management unit may, on receipt of the operation  
instruction, (i) reply in the affirmative and update the  
in-group remaining number or reply in the negative, based  
on the in-group remaining number, when the playback apparatus  
is judged to belong to the group, and (ii) reply in the  
15 affirmative and update the out-group remaining number or  
reply in the negative, based on the out-group remaining  
number, when the playback apparatus is judged to not belong  
to the group.

According to this structure, duplication/deletion of  
20 contents is conducted efficiently at a predetermined time,  
such as when network traffic is low, thus enabling user  
convenience to be improved.

(5) Also, the request may include a usage expiry  
date-time of the content, the content-duplication management

apparatus may further include a time management unit that includes a clock and is operable, when the usage expiry date-time is shown by the clock, to output an operation instruction to the management unit, and the management unit  
5 may, on receipt of the operation instruction, (i) add "1" to the in-group remaining number when the playback apparatus is judged to belong to the group, and (ii) add "1" to the out-group remaining number when the playback apparatus is judged to not belong to the group.

10       According to this structure, unrestricted duplication/usage of contents is prevented by limiting content usage to a predetermined usage expiry date-time, thus enabling copyright protection to be strengthened.

(6) Also, the management unit may notify to the playback  
15 apparatus, transfer information showing a number that is less than or equal to at least one of the in-group remaining number and the out-group remaining number, and subtract the number shown by the transfer information from the at least one of the in-group remaining number and the out-group remaining  
20 number.

According to this structure, user convenience is improved by dispersing the management authorization to duplicate contents, thus dispersing the burden on the system with respect to content duplication and speeding up

processing.

(7) Also, the management unit may hold duplication-generation information relating to the content, and (i) reply in the affirmative and update the in-group remaining number or reply in the negative, based on the duplication-generation information and the in-group remaining number, when the playback apparatus is judged to belong to the group, and (ii) reply in the affirmative and update the out-group remaining number or reply in the negative, based on the duplication-generation information and the out-group remaining number, when the playback apparatus is judged to not belong to the group.

According to this structure, the unrestricted diffusion of contents is prevented by restricting the generation of a duplicated content, thus enabling copyright protection to be strengthened.

(8) Also, the request may include request-apparatus information unique to the playback apparatus, and the management unit may hold a revocation list showing one or more apparatuses to which content duplication is not permitted, and (i) reply in the affirmative and update the in-group remaining number or reply in the negative, based on the request-apparatus information, the revocation list and the in-group remaining number, when the playback

apparatus is judged to belong to the group, and (ii) reply in the affirmative and update the out-group remaining number or reply in the negative, based on the request-apparatus information, the revocation list and the out-group remaining  
5 number, when the playback apparatus is judged to not belong to the group.

According to this structure, since duplication of contents by illegitimate apparatuses is prevented using a revocation list, copyright protection can be strengthened.

10 (9) Also, the request may include request-area information showing an area relating to the playback apparatus, and the management unit may hold specified area information that is for restricting an area in which duplication and deletion of the content is executed, and (i)  
15 reply in the affirmative and update the in-group remaining number or reply in the negative, based on the request-area information, the specified area information and the in-group remaining number, when the playback apparatus is judged to belong to the group, and (ii) reply in the affirmative and  
20 update the out-group remaining number or reply in the negative, based on the request-area information, the specified area information and the out-group remaining number, when the playback apparatus is judged to not belong to the group.

According to this structure, the unrestricted diffusion of contents is prevented by geographically restricting the rights of content duplication, thus enabling copyright protection to be strengthened.

5           (10) Also, the content-duplication management apparatus may further include an authentication unit operable to share a session key with the playback apparatus by conducting authentication processing with the playback apparatus; and an encryption/decryption unit operable, if  
10 authentication is successful, to encrypt and decrypt communication with the playback apparatus using the session key.

According to this structure, since communication is encrypted, the normal playback of contents improperly  
15 acquired from a communication channel is prevented, thus enabling copyright protection to be strengthened.

          (11) Also, the content-duplication management apparatus may further include a request accumulation unit operable to manage the requests using a request-arrival  
20 sequence queue, and to have the management unit execute a deletion request that is subsequent in the queue to a duplication request, prior to the duplication request, when the in-group or out-group remaining number is "0".

According to this structure, because requests joined

in a queue are efficiently processed by giving priority to executable processing out of the processing shown by the requests in the queue, user convenience is improved.

(12) Also, the network may be a home network connected to an external network, the content may be acquired from outside the home network, and the group judging unit may judge apparatuses connected to the home network as belonging to the group.

According to this structure, the unrestricted diffusion of contents to apparatuses connected outside a home network is prevented, thus enabling copyright protection to be strengthened.

(13) A content-duplication management method of the present invention is for managing duplication and deletion of a content with respect to a playback apparatus connected to a network, based on requests acquired from the playback apparatus, and including the steps of: judging whether the playback apparatus belongs to a predetermined group; holding an in-group remaining number and an out-group remaining number, the in-group remaining number being a remaining number of duplications of the content permitted of apparatuses belonging to the group, and the out-group remaining number being a remaining number of duplications of the content permitted of apparatuses not belonging to the

group; and in response to a request acquired from the playback apparatus, (i) replying in the affirmative and updating the in-group remaining number or replying in the negative, based on the in-group remaining number, when the playback apparatus  
5 is judged to belong to the group, and (ii) replying in the affirmative and updating the out-group remaining number or replying in the negative, based on the out-group remaining number, when the playback apparatus is judged to not belong to the group.

10       According to this structure, the number of duplications to in-group and out-group apparatuses is managed separately, thus allowing for copyright protection by stiffening restrictions on content duplication to out-group apparatuses, and for improvements in user convenience by relaxing  
15 restrictions on content duplication to in-group apparatuses.

(14) A computer program of the present invention is applied in a content-duplication management apparatus that manages duplication and deletion of a content with respect to a playback apparatus connected to a network, based on  
20 requests acquired from the playback apparatus, and includes the steps of: judging whether the playback apparatus belongs to a predetermined group; holding an in-group remaining number and an out-group remaining number, the in-group remaining number being a remaining number of duplications



of the content permitted of apparatuses belonging to the group, and the out-group remaining number being a remaining number of duplications of the content permitted of apparatuses not belonging to the group; and in response to  
5 a request acquired from the playback apparatus, (i) replying in the affirmative and updating the in-group remaining number or replying in the negative, based on the in-group remaining number, when the playback apparatus is judged to belong to the group, and (ii) replying in the affirmative and updating  
10 the out-group remaining number or replying in the negative, based on the out-group remaining number, when the playback apparatus is judged to not belong to the group.

According to this structure, the number of duplications to in-group and out-group apparatuses is managed separately,  
15 thus allowing for copyright protection by stiffening restrictions on content duplication to out-group apparatuses, and for improvements in user convenience by relaxing restrictions on content duplication to in-group apparatuses.

(15) Also, a playback apparatus of the present  
20 invention requests duplication and deletion of a content, with respect to a content-duplication management apparatus as in claim 1 that manages duplication and deletion of the content, the playback apparatus including: a request unit operable to request duplication or deletion of the content;

a group notifying unit operable to notify to the content-duplication management apparatus, group information showing a group that the playback apparatus belongs to; an acquiring unit operable to acquire from the  
5 content-duplication management apparatus, permission information showing whether the request is permitted; and an execution unit operable to duplicate or delete the content, based on the permission information.

According to this structure, because information  
10 relating to an affiliated group is provided to a management apparatus that separately manages the number of duplications to in-group and out-group apparatuses, and contents are duplicated based on the response to information provided, copyright protection can be provided by stiffening  
15 restrictions on content duplication in the case of out-group apparatuses, and user convenience can be improved by relaxing restrictions on content duplication in the case of in-group apparatuses.

(16) Also, the playback apparatus may further include  
20 a broadcast transmitting unit operable to broadcast to apparatuses over a network, identification information identifying the content whose duplication or deletion is requested; a reply receiving unit operable to receive a response to the broadcasted identification information; and

a selecting unit operable to select, based on a predetermined condition, one apparatus from apparatuses that respond to the broadcast. Furthermore, the request unit may request the selected apparatus for permission to duplicate the content.

5        According to this structure, since it is possible to select, as a delivery apparatus from a plurality of apparatuses, an apparatus that meets a predetermined condition using broadcast communication, user convenience can be improved.

10        (17) Also, the apparatuses over the network may each have a preset priority level, and the selecting unit may select, from the apparatuses that respond, the apparatus having the highest priority level.

      According to this structure, because duplication  
15        processing is executed after selecting, as the delivery apparatus, an apparatus having the highest priority level among apparatuses that respond, user convenience can be improved.

      (18) Also, the apparatuses over the network may each  
20        prehold capability information showing an information processing capability of the apparatus, the response may include the capability information, and the selecting unit may select, from the apparatuses that respond, the apparatus having capability information that shows the highest

information processing capability.

According to this structure, because duplication processing is executed after selecting, as the delivery apparatus, an apparatus having the highest information  
5 processing capability among apparatuses that respond, user convenience can be improved.

(19) Also, the selecting unit may select the first apparatus to respond.

According to this structure, because duplication  
10 processing is executed after selecting the first apparatus to respond as the delivery apparatus, user convenience can be improved.

(20) Also, the selecting unit may select, from the apparatuses that respond, the apparatus having the shortest  
15 round-trip time between an ICMP echo request message and an ICMP echo reply message.

According to this structure, because duplication processing is executed after selecting as the delivery apparatus the apparatus able to communicate the fastest, user  
20 convenience can be improved.

(21) Also, the content-duplication management apparatus may notify to the playback apparatus, transfer information showing a number that is less than or equal to at least one of the in-group remaining number and the

out-group remaining number, and the playback apparatus may further include a management unit operable to acquire the transfer information, and to permit decryption of the content within a range of the number shown by the transfer information,  
5 with respect to another apparatus.

According to this structure, since duplication management of contents is executed in conjunction with a delivery apparatus by receiving transfer of management authorization to duplicate contents with respect to another  
10 apparatus, efficient duplication of contents becomes possible while reducing the burden of content duplication management, thus enabling user convenience to be improved.

(22) Also, the permission information may include a usage expiry date-time of the content, and the playback  
15 apparatus may further include a clock; and a management unit operable to delete the content when the usage expiry date-time is shown by the clock.

According to this structure, unrestricted duplication/usage of contents is prevented by limiting  
20 content usage to a predetermined usage expiry date-time, thus enabling copyright protection to be strengthened.

(23) Also, the playback apparatus may further include an authentication unit operable to share a session key with the content-duplication management apparatus by conducting

authentication processing with the content-duplication management apparatus; and an encryption/decryption unit operable, if authentication is successful, to encrypt and decrypt communication with the content-duplication management apparatus using the session key.

According to this structure, since communication is encrypted, the normal playback of contents improperly acquired from a communication channel is prevented, thus enabling copyright protection to be strengthened.

10       (24) Also, the playback apparatus may be a recording medium having an IC.

According to this structure, because information relating to an affiliated group is provided to a management apparatus that separately manages the number of duplications to in-group and out-group apparatuses, and contents are duplicated based on the response to information provided, copyright protection can be provided by stiffening restrictions on content duplication in the case of out-group apparatuses, and user convenience can be improved by relaxing restrictions on content duplication in the case of in-group apparatuses.

(25) A playback method of the present invention is for requesting duplication and deletion of a content, with respect to a content-duplication management apparatus as in

claim 1 that manages duplication and deletion of the content,  
the playback method including the steps of: requesting  
duplication or deletion of the content; notifying to the  
content-duplication management apparatus, group information  
5 showing a group that the playback apparatus belongs to;  
acquiring from the content-duplication management apparatus,  
permission information showing whether the request is  
permitted; and duplicating or deleting the content, based  
on the permission information.

10 According to this structure, because information  
relating to an affiliated group is provided to a management  
apparatus that separately manages the number of duplications  
to in-group and out-group apparatuses, and the management  
apparatus is made to judge as to whether to stiffen content  
15 duplication restrictions to provide copyright protection or  
to relax content duplication restrictions to improve user  
convenience, it is possible to duplicate contents  
appropriately based on the judgment result.

(26) A computer program of the present invention is  
20 applied in a playback apparatus that requests duplication  
and deletion of a content, with respect to a  
content-duplication management apparatus as in claim 1 that  
manages duplication and deletion of the content, the computer  
program including the steps of: requesting duplication or

deletion of the content; notifying to the content-duplication management apparatus, group information showing a group that the playback apparatus belongs to; acquiring from the content-duplication management apparatus,  
5 permission information showing whether the request is permitted; and duplicating or deleting the content, based on the permission information.

According to this structure, because information relating to an affiliated group is provided to a management  
10 apparatus that separately manages the number of duplications to in-group and out-group apparatuses, and the management apparatus is made to judge as to whether to stiffen content duplication restrictions to provide copyright protection or to relax content duplication restrictions to improve user  
15 convenience, it is possible to duplicate contents appropriately based on the judgment result.

(27) Also, a content-duplication management system of the present invention includes a playback apparatus that requests and plays a content, and a content-duplication  
20 management apparatus that is connected to the playback apparatus via a network and manages duplication and deletion of the content with respect to the playback apparatus. The playback apparatus includes: a request unit operable to request duplication or deletion of the content; a group



notifying unit operable to notify to the content-duplication management apparatus, group information showing a group that the playback apparatus belongs to; an acquiring unit operable to acquire from the content-duplication management apparatus,  
5 permission information showing whether the request is permitted; and an execution unit operable to duplicate or delete the content, based on the permission information. On the other hand, the content-duplication management apparatus includes: a group judging unit operable to judge whether the  
10 playback apparatus belongs to a predetermined group, based on the group information notified from the playback apparatus; a holding unit operable to hold an in-group remaining number and an out-group remaining number, the in-group remaining number being a remaining number of  
15 duplications of the content permitted of apparatuses belonging to the predetermined group, and the out-group remaining number being a remaining number of duplications of the content permitted of apparatuses not belonging to the predetermined group; and a management unit operable, in  
20 response to the request acquired from the playback apparatus, to (i) reply in the affirmative and update the in-group remaining number or reply in the negative, based on the in-group remaining number, when the playback apparatus is judged to belong to the predetermined group, and (ii) reply

in the affirmative and update the out-group remaining number or reply in the negative, based on the out-group remaining number, when the playback apparatus is judged to not belong to the predetermined group.

5           According to this structure, a content-duplication management apparatus conducts controls to separately manage the number of duplications to in-group and out-group apparatuses, to provide copyright protection by stiffening restrictions on content duplication to out-group apparatuses,  
10   and to improve user convenience by relaxing restrictions on content duplication to in-group apparatuses, and a content playback apparatus operates in accordance with the controls, thus enabling a strengthening of copyright protection and improvements in user convenience to be realized.

15           (28) Also, the content-duplication management apparatus may request an accounting system to manage accounting, when the management unit replies in the affirmative.

          According to this structure, it is possible to conduct  
20   accounting with respect to content duplication, thus enabling copyright protection to be strengthened.

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

These and other objects, advantages and features of the

invention will become apparent from the following description thereof taken in conjunction with the accompanying drawings that illustrate specific embodiments of the present invention.

5

In the drawings:

Fig.1 is a block diagram showing an overall structure of a group formation/management system 1;

Fig.2 is a block diagram showing a structure of an AD server  
10 100;

Fig.3 shows a structure of registration information;

Fig.4 is a block diagram showing a structure of a playback apparatus 200;

Fig.5 is a block diagram showing a structure of an on-vehicle  
15 device 300;

Fig.6 is a block diagram showing a structure of an IC card 400;

Fig.7 is a flowchart showing SAC establishment processing (cont. in Fig.8);

20 Fig.8 is a flowchart showing SAC establishment processing (cont. from Fig.7);

Fig.9 is a flowchart showing operations by which AD server 100 registers playback apparatus 200;

Fig.10 is a flowchart showing operations by which AD server

100 registers on-vehicle device 300;

Fig.11 is a flowchart showing operations by which AD server  
100 registers on-vehicle device 300;

Fig.12 is a flowchart showing operations to deliver a  
5 content;

Fig.13 is a flowchart showing part of the operations to  
deliver a content;

Fig.14 is a flowchart showing operations to record a content  
onto a DVD;

10 Fig.15 is a flowchart showing operations to withdraw from  
AD server 100;

Fig.16 is block diagram showing a structure of a key delivery  
system 1000;

Fig.17 is block diagram showing a structure of a content  
15 server 1001;

Fig.18 is block diagram showing a structure of a content  
storage unit 1011;

Fig.19 is block diagram showing a structure of a management  
information storage unit 1012;

20 Fig.20 shows a data structure of a key information table T1001  
included in a key-information storage unit 1031;

Fig.21 shows a data structure of a delivered key information  
table T1002 included in a delivered key-information  
storage unit 1032;

Fig.22 is block diagram showing a structure of a recording medium 1002;

Fig.23 shows a data structure of a delivered content key table T1101 included in a usage-key storage unit 1102;

5 Fig.24 is block diagram showing a structure of a playback apparatus 1003;

Fig.25 is block diagram showing a structure of a playback apparatus 1004;

Fig.26 is a flowchart showing content key management processing (cont. in Fig.27);

Fig.27 is a flowchart showing content key management processing (cont. from Fig.28);

Fig.28 is a flowchart showing authentication processing;

Fig.29 is a flowchart showing time management processing;

15 Fig.30 is a flowchart showing operations at a playback time in playback apparatus 1004;

Fig.31 is a flowchart showing operations at a playback time in playback apparatus 1003;

Fig.32 is a flowchart showing operations at a usage time of recording medium 1002 in content server 1001;

Fig.33 is a flowchart showing operations at a playback time in content server 1001;

Fig.34 is a flowchart showing key confirmation processing;

Fig.35 is a flowchart showing operations at a time of advance

delivery of a content key;

Fig.36 is a block diagram showing a structure of a content-duplication management system 2000;

Fig.37 is a block diagram showing a structure of a content

5 server 2001;

Figs.38A/38B show information held by a duplication-restriction information management unit 2102;

Fig.39 is a block diagram showing a structure of a playback  
10 apparatus 2002;

Fig.40 is a block diagram showing a structure of a playback apparatus 2003 and an internal IC portable recording medium 2004;

Fig.41 is a block diagram showing a structure of a playback  
15 apparatus 2006;

Fig.42 is a flowchart showing duplication-source determination processing;

Fig.43 is a flowchart showing mutual device authentication and key sharing operations conducted between a delivery  
20 apparatus and a request apparatus (cont. in Fig.44);

Fig.44 is a flowchart showing mutual device authentication and key sharing operations conducted between a delivery apparatus and a request apparatus (cont. from Fig.43);

Fig.45 is a flowchart showing duplication processing;

Fig.46 is a flowchart showing duplication-restriction information transfer processing;

Fig.47 is a flowchart showing usage period management processing to manage contents whose usage expiry date-time has been determined;

5 Fig.48 is a flowchart showing duplication reservation processing;

Fig.49 is a flowchart showing return processing;

10 Fig.50 is a block diagram showing a structure in which a representative device representing a plurality of client devices registers in an AD server 600;

Fig.51 shows conceptually the formation of a single group from a plurality of groups; and

15 Fig.52 shows conceptually the division of a single group to form a plurality of groups.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

An embodiment of the present invention will now be described in detail with reference to the drawings.

20

### 1. Structure of Group Formation/Management System

As shown in Fig.1, a group formation/management system 1 is structured from an authorized domain (AD) server 100, a playback apparatus 200, an on-vehicle device 300, an IC

card 400, and a DVD 500.

AD server 100 and playback apparatus 200, which is connected to a monitor 251 and a speaker 252, are disposed in a user's home and are connected online. On-vehicle device  
5 300 is mounted in a vehicle owned by the user. IC card 400 and DVD 500 are connectable to AD server 100 and on-vehicle device 300. IC card 400 is affiliated with AD server 100, and AD server 100 only operates when IC card 400 is connected thereto.

10       Group formation/management system 1 is a system in which AD server 100 manages an authorized domain (AD), being a range within which content usage is permitted.

AD server 100 receives and manages the registration of client devices, and AD server 100 and registered client  
15 devices share common secret information (CSI) generated by AD server 100. Mutual authentication using shared CSI is conducted among devices within the same authorized domain, and when authorization is successful, transmission/reception, copying and the like of contents is  
20 conducted among these devices. Because the CSI differs between authorized domains, devices not holding the CSI of the authorized domain managed by AD server 100 cannot transmit/receive or copy contents available within the authorized domain of AD server 100.



Playback apparatus 200 is connected to AD server 100 and is thus able to conduct authentication and to register as a client device. Also, on-vehicle device 300, although not connected to AD server 100, is able to register as a client device by having CSI stored on IC card 400 and notifying the CSI from IC card 400 to on-vehicle device 300.

### 1.1 Structure of AD Server 100

As shown in Fig.2, AD server 100 is structured from a control unit 101, a secret-key storage unit 102, a public-key-certificate storage unit 103, a CRL storage unit 104, a public-key-encryption processing unit 105, a registration-information storage unit 106, a CSI generation unit 107, a CSI storage unit 108, a content storage unit 109, an encryption unit 110, an ID storage unit 111, a drive unit 112, an input unit 113, a display unit 114, an input/output (IO) unit 115, an input/output (IO) unit 116, a decryption unit 117, a content-key storage unit 118, and an encryption unit 119.

AD server 100 is specifically a computer system structured from a microprocessor, a ROM, a RAM, a hard disk unit and the like. A computer program is stored on the RAM or the hard disk unit. AD server 100 carries out functions as a result of the microprocessor operating in accordance

with the computer program.

AD server 100 conducts processing to register devices, manage copying of CSI and withdrawals, deliver contents, and copy contents.

5 Each of the elements will now be described.

(1) *IO Unit 115, 116, Drive Unit 112*

IO unit 115 conducts transmission/reception of data with playback apparatus 200. IO unit 116, when the connection  
10 of IC card 400 is detected, outputs the detection to control unit 101. Also, IO unit 116 conducts transmission/reception of data with IC card 400. Drive unit 112 writes/reads data to/from DVD 500.

15 (2) *Secret-Key Storage Unit 102, Public-Key-Certificate Storage Unit 103, CRL Storage Unit 104, Content Storage Unit 109, ID Storage Unit 111, Content-Key Storage Unit 118*

ID storage unit 111 stores an *ID\_1*, which is an identifier (ID) unique to AD server 100.

20 Public-key-certificate storage unit 103 stores a public key certificate (PKC) *Cert\_1*.

PKC *Cert\_1* certifies that a public key *PK\_1* is the legitimate public key of AD server 100. PKC *Cert\_1* includes signature data *Sig\_CA1*, public key *PK\_1*, and *ID\_1*. Signature

data *Sig\_CA1* is generated by a certification authority (CA) performing a signature algorithm *S* on public key *PK\_1* and *ID\_1*. Here, a CA is a reliable third party authority, and issues public key certificates certifying the legitimacy of  
5 the public keys of devices belonging to group formation/management system 1. Moreover, signature algorithm *S* is, as one example, an ElGamal signature over a finite field. Since ElGamal signatures are known technology, a description is omitted here.

10 Secret-key storage unit 102 is a tamper-resistant area that cannot be viewed from outside, and stores a secret key *SK\_1* corresponding to public key *PK\_1*.

CRL storage unit 104 stores a certificate revocation list (CRL). A CRL is a list, issued by a CA, in which are  
15 registered the IDs of invalidated devices, which are devices that have conducted improper processing, devices whose secret key has been disclosed, and the like. Moreover, it need not be device IDs that are registered in a CRL, but may be the serial numbers of public key certificates held by  
20 invalidated devices. A CRL is distributed to devices, for example, via a broadcast, the Internet or stored on a recording medium such as DVD, and devices obtain the most recent CRL. Moreover, a detailed discloser of CRLs can be found in the American National Standards Institute's ANSI

X9.57: "Public Key Cryptography for the Financial Services Industry: Certificate Management," 1997.

Content storage unit 109 stores encrypted contents encrypted using content keys. Moreover, although the method  
5 of acquiring contents is not the subject of the present invention and a description is thus omitted here, acquisition methods include, for example, acquiring contents using the Internet, broadcasts or the like, or acquiring contents from a recording medium such as a DVD.

10 Content-key storage unit 118 receives an encrypted content key *a* from encryption unit 110, and stores the encrypted content key *a*.

### *(3) Public-Key-Encryption Processing Unit 105*

15 Public-key-encryption processing unit 105 conducts authentication at a time of communicating with another device, and establishes a secure authenticated channel (SAC). A SAC refers to a safe communication channel that enables encrypted communication. As a result of processing to establish a SAC,  
20 it is possible to confirm that the device being authenticated is a legitimate device recognized by the CA. A detailed description of the SAC establishment method is given later. Also, unit 105, as a result of the authentication, shares a session key *SK*.

(4) *Registration-Information Storage Unit 106*

Registration-information storage unit 106 is a tamper-resistant area, and stores registration information as shown in Fig.3A. Registration information is information  
5 for managing the number of devices registerable in AD server 100 and the ID of registered devices, and is structured from DEVICE ID, MAXIMUM, REGISTERED, REMAINING, and IC CARD ID.

DEVICE ID is an area storing the ID of devices  
10 registered in AD server 100. When playback apparatus 200 and on-vehicle device 300 are registered in AD server 100, an ID\_2 and an ID\_3, being the respective IDs of devices 200 and 300, are stored, as shown in Fig.3B.

MAXIMUM shows the maximum number of devices  
15 registerable in AD server 100, the maximum number being two in the present embodiment. REGISTERED shows the number of devices already registered in AD server 100. REMAINING shows the remaining number of devices registerable in AD server 100.

20 In an initial state in which no client devices are registered in the authorized domain managed by AD server 100, the registered number (REGISTERED) is "0", and the remaining number (REMAINING) has the same value as the maximum number (MAXIMUM). When a client device is registered in the

authorized domain by AD server 100, "1" is added to the registered number, and "1" is subtracted from the remaining number.

IC CARD ID prestores the ID of IC card 400 affiliated  
5 with AD server 100, and cannot be rewritten.

*(5) CSI Generation Unit 107, CSI Storage Unit 108*

CSI storage unit 108 is a tamper-resistant area storing a CSI that cannot be read from outside, and stores, when no  
10 devices are registered in AD server 100, "0" as a value showing that no devices are registered.

CSI generation unit 107 generates CSI when a device is initially registered in AD server 100, under the control of control unit 101. Also, when all of devices withdraw, CSI  
15 storage unit 108 rewrites the stored value to "0".

Here, CSI is arbitrary data generated by CSI generation unit 107, and has a 200-bit length in the present embodiment. Moreover, the bit length of the CSI is not limited to this, and may be any length that is not readily estimatable, and  
20 that cannot be easily tested.

CSI generation unit 107 stores generated CSI in CSI storage unit 108. Also, unit 107 outputs generated CSI to IC card 400 when connected.

Moreover, CSI may be updated regularly or irregularly.

(6) *Encryption Unit 110, Encryption Unit 119*

Encryption unit 119, at a time of playback apparatus 200 being registered and under the control of control unit 101, performs an encryption algorithm  $E$  on CSI using a session key  $SK$  received from public-key-encryption processing unit 105 to generate encrypted CSI, and transmits the encrypted CSI to playback apparatus 200 via IO unit 115. Here, encryption algorithm  $E$  is, as one example, a Data Encryption Standard (DES) algorithm. Since DES algorithms are known technology, a description is omitted here.

Encryption unit 110, at a time of storing a content key in content-key storage unit 118, reads  $ID\_1$  from ID storage unit 111 and reads CSI from CSI storage unit 108. Unit 110 concatenates the read  $ID\_1$  and CSI in the stated order to generate an encryption key  $a$ , performs an encryption algorithm  $E$  on the content key using encryption key  $a$  to generate encrypted content key  $a$ , and outputs encrypted content key  $a$  to content-key storage unit 118.

Encryption unit 110, at a time of writing an encrypted content onto DVD 500 and under the control of control unit 101, reads  $ID\_2$  and  $ID\_3$ , which are the IDs of the registered devices, from DEVICE ID of the registered information in registration-information storage unit 106. Unit 110

concatenates *ID\_2* and CSI in the stated order to generate an encryption key *b*, and concatenates *ID\_3* and CSI in the stated order to generate an encryption key *c*. An encrypted content key *b* and an encrypted content key *c* are generated respectively using encryption key *b* and encryption key *c*, and written to DVD 500.

(7) *Decryption Unit 117*

Decryption unit 117, under the control of control unit 101, reads *ID\_1* stored in ID storage unit 111 and reads CSI stored in CSI storage unit 108. Unit 117 performs a decryption algorithm *D* on encrypted content key *a* read from content-key storage unit 118, using a decryption key generated by concatenating the read *ID\_1* and CSI in the stated order, to obtain a content key. Unit 117 outputs the obtained content key to encryption unit 110. Here, decryption algorithm *D* is an algorithm for conducting the reverse processing of encryption algorithm *E*.

(8) *Control Unit 101, Input Unit 113, Display Unit 114*

Input unit 113 receives inputs from a user, and outputs the received inputs to control unit 101.

At a time of starting processing, control unit 101, on receipt of an IC card ID from connected IC card 400, confirms



whether the received ID matches the IC card ID in the registration information. If not matched, control unit 101 displays on display unit 114 the fact that the connected IC card is not the IC card affiliated with AD server 100, and  
5 ends the processing. If matched, control unit 101 continues the processing as follows.

#### *Registration of Playback Apparatus 200*

On receipt of a registration request from playback apparatus 200 via IO unit 115, control unit 101 controls  
10 public-key-encryption processing unit 105, and establishes a SAC using a CSI initial value "0", by the SAC establishment method to be described later (here, the CSI initial value "0" used at a time of registration indicates that playback apparatus 200 has yet to be registered). From the result of  
15 the device authentication at a time of establishing the SAC, control unit 101 judges whether the target device has an authorized public key pair and whether the target device is unregistered. If the target device has the authorized public key pair and CSI having a "0" value, authentication is judged  
20 to be successful. If the target device does not hold CSI having a "0" value, control unit 101 judges the target device to already be registered in another authorized domain. Moreover, whether or not the authorized domain in which the target device is registered is the authorized domain managed by AD

server 100 may be judged by confirming whether the CSI of the target device matches the CSI stored in CSI storage unit 108.

When judged that the target device is unregistered,  
5 control unit 101 reads registration information from registration-information storage unit 106, and judges whether the remaining number of devices is "0". If the remaining number is not "0", control unit 101 judges whether the registered number is "0". If the registered number is  
10 "0", control unit 101 controls CSI generation unit 107 to generate CSI, and stores the generated CSI in CSI storage unit 108. If the registered number is not "0", control unit 101 reads CSI from CSI storage unit 108, has the generated or read CSI encrypted by encryption unit 110 to generate  
15 encrypted CSI, and outputs the encrypted CSI to playback apparatus 200 via IO unit 115. On receipt from playback apparatus 200 of a receipt notification showing that the outputted CSI has been received, control unit 101 adds "1" to the registered number in the registration information,  
20 subtracts "1" from the remaining number, and ends the processing.

If authentication is unsuccessful, or if the target device is registered, or if the remaining number is "0", control unit 101 transmits a registration failure

notification to playback apparatus 200 showing that registration is not possible, and ends the processing.

Also, at a time of CSI being generated by CSI generation unit 107, control unit 101 establishes a SAC with IC card 400 and shares session key *SK*, performs encryption algorithm  
5 *E* on the generated CSI using session key *SK* to generate encrypted CSI, and transmits the encrypted CSI to IC card 400.

#### *Registration of On-vehicle 300*

10 (a) On receipt of an input from input unit 113 showing the copying of CSI when IC card 400, whose ID has already been confirmed, is connected, control unit 101 judges whether the remaining number is "0", and if not "0", transmits a permission right to IC card 400 showing that a once-only copy  
15 of CSI is permitted. Control unit 101, on receipt from IC card 400 of a receipt notification, ends the processing.

When the remaining number is "0", control unit 101 displays the fact that copying is not possible on display unit 114, and ends the processing.

20 (b) When IC card 400 is connected to AD server 100, AD server 100 confirms that the IC card ID has been registered in the registration information, and on receipt of a copy notification showing that CSI has been copied, control unit 101 extracts the ID of the CSI copy target (i.e. on-vehicle

device 300), which is included in the copy notification, and stores the extracted ID as a device ID in the registration information. Also, control unit 101 transmits a receipt notification to IC card 400 showing that the copy target ID  
5 has been received.

Moreover, although the above description relates here to CSI having been generated, when CSI has not being generated, CSI is generated and transmitted to IC card 400 in the same manner as when playback apparatus 200 is registered.

#### 10        *Content Delivery*

On receipt of a content delivery request from playback apparatus 200 via IO unit 115, control unit controls public-key-encryption processing unit 105 to establish a SAC using the SAC establishment method to be described later,  
15 and shares session key *SK*. Since CSI stored in CSI storage unit 108 is used in authentication conducted at the time of establishing the SAC, when authentication is successful, control unit 101 judges that the target device is registered because of the target device holding CSI generated in AD  
20 server 100, and when authentication is unsuccessful, control unit 101 judges that the target device is not registered in AD server 100.

When authentication is unsuccessful, control unit 101 transmits a delivery failure notification to playback

apparatus 200 showing that distribution of contents is not possible.

When authentication is successful, control unit 101 controls decryption unit 117 to decrypt encrypted content key  $a$  stored in content-key storage unit 118 to obtain a content key. Next, control unit 101 controls encryption unit 110 to encrypt the content key using session key  $SK$  to generate an encrypted content key  $s$ , and transmits encrypted content key  $s$  to playback apparatus 200. Also, control unit 101 reads an encrypted content from content storage unit 109, and transmits the encrypted content to playback apparatus 200.

#### *Recording of a Content onto DVD*

On receipt of an input from input unit 113 indicating to record a content onto DVD 500, control unit 101 controls decryption unit 117 to decrypt encrypted content key  $a$  stored in content-key storage unit 118 to obtain a content key. Next, control unit 101 controls encryption unit 110 to encrypt the content key using encryption key  $b$  and encryption key  $c$  generated respectively using  $ID\_2$  and  $ID\_3$  registered in the registration information to generate encrypted content key  $b$  and encrypted content key  $c$ , and writes the encrypted content keys  $b$  and  $c$  to DVD 500. Also, control unit 101 reads an encrypted content from content storage unit 109 and writes the encrypted content to DVD 500.

Moreover, the content key may be encrypted using an encryption key generated based on an ID unique to DVD 500, or an encryption key generated based on the DVD 500 ID and CSI.

5           *Withdrawal*

On receipt from playback apparatus 200 of a withdrawal request that includes *ID\_2*, control unit 101 controls public-key-encryption processing unit 105 to establish a SAC using the SAC establishment method to be described later.

10   At this time, control unit 101 conducts authentication using CSI stored in CSI storage unit 108. From the authentication result at the time of establishing the SAC, control unit 101 judges whether the device that sent the request is registered, and if the target device is unregistered, control unit 101

15   transmits an unregistered notification to playback apparatus 200 showing playback apparatus 200 to be unregistered, since it is impossible to withdraw in this case.

When playback apparatus 200 is registered, control unit 101 transmits a deletion notification to playback apparatus

20   200 indicating to delete CSI. On receipt of a deletion-completed notification from playback apparatus 200 showing that deletion of the CSI has been completed, control unit 101 deletes *ID\_2* from DEVICE ID in the registration information, subtracts "1" from the registered number, and

adds "1" to the remaining number.

## 1.2 Structure of Playback apparatus 200

As shown in Fig.4, playback apparatus 200 is structured  
5 from a control unit 201, a secret-key storage unit 202, a  
public-key-certificate storage unit 203, a CRL storage unit  
204, a public-key-encryption processing unit 205, a CSI  
storage unit 208, a content storage unit 209, an ID storage  
unit 211, an input unit 213, an input/output (IO) unit 215,  
10 a decryption unit 217, an encryption unit 218, a content-key  
storage unit 219, a decryption unit 220, and a playback unit  
221. A monitor 251 and a speaker 252 are connected to playback  
unit 221.

Playback apparatus 200 is a computer system the same  
15 AD server 100, and a computer program is stored in the RAM  
or the hard disk unit. Playback apparatus 200 carries out  
functions as a result of the microprocessor operating in  
accordance with the computer program.

### 20 (1) IO Unit 215

IO unit 215 conducts transmission/reception of data  
with AD server 100.

### (2) Secret-Key Storage Unit 202, Public-Key-Certificate

*Storage Unit 203, CRL Storage Unit 204, CSI Storage Unit 208,  
ID Storage Unit 211*

CRL storage unit 204 stores the most recent CRL.

ID storage unit 211 stores *ID\_2*, which is the ID unique  
5 to playback apparatus 200.

CSI storage unit 208 is a tamper-resistant area, and  
stores "0" showing playback apparatus 200 to be unregistered.  
When playback apparatus 200 is registered in AD server 100,  
CSI storage unit 208 stores CSI acquired from AD server 100.

10 Public-key-certificate storage unit 203 stores a PKC  
*Cert\_2* issued by the CA. PKC *Cert\_2* includes a public key  
*PK\_2* of playback apparatus 200, *ID\_2* of playback apparatus  
200, and signature data *Sig\_CA2* generated by the CA  
performing signature algorithm *S* on public key *PK\_2* and *ID\_2*.

15 Secret-key storage unit 202 is a tamper-resistant area,  
and stores a secret key *SK\_2* corresponding to public key *PK\_2*  
of playback apparatus 200.

### *(3) Public-Key-Encryption Processing Unit 205*

20 Public-key-encryption processing unit 205 establishes  
a SAC by the SAC establishment method to be described later,  
at a time of communicating with AD server 100, and shares  
session key *SK*. Unit 205 outputs the shared session key *SK*  
to decryption unit 217.



(4) *Decryption Unit 217, Decryption Unit 220*

Decryption unit 217, at a time of a content being distributed from AD server 100, performs decryption  
5 algorithm  $D$  on encrypted content key  $s$  delivered from AD server 100, using session key  $SK$  shared by public-key-encryption processing unit 205, to obtain a content key. Here, decryption algorithm  $D$  is an algorithm for conducting the reverse processing of encryption  
10 algorithm  $E$ .

Also, at a time of playing a content once stored, decryption unit 217 reads  $ID\_2$  from ID storage unit 211, reads CSI from CSI storage unit 208, and concatenates the reads  $ID\_2$  and CSI in the stated order to generate a decryption  
15 key  $b$ . Decryption unit 217 performs decryption algorithm  $D$  on encrypted content key  $b$  read from content-key storage unit 219, using the generated decryption key  $b$ , to obtain a content key, and outputs the obtained content key to decryption unit 220.

20 Decryption unit 220 reads an encrypted content stored in content storage unit 209, performs decryption algorithm  $D$  on the encrypted content using the content key received from decryption unit 217 to obtain a content, and outputs the obtained content to playback unit 221.

(5) *Encryption Unit 218*

Encryption unit 218, at a time of storing a content acquired from AD server 100, reads *ID\_2* from ID storage unit 211, and reads CSI from CSI storage unit 208. Unit 218 concatenates the read *ID\_2* and CSI in the stated order to generate encryption key *b*, and performs encryption algorithm *E* on the content key received from decryption unit 217 using the generated encryption key *b* to generate encrypted content key *b*, and outputs encrypted content key *b* to content-key storage unit 219.

(6) *Content Storage Unit 209, Content-Key Storage Unit 219*

Content storage unit 209 stores encrypted contents transmitted from AD server 100.

Content-key storage unit 219 stores encrypted content key *b* encrypted by encryption unit 218.

(7) *Control Unit 201, Input Unit 213*

20      *Registration*

On receipt by input unit 213 of an input indicating to start the registration processing, control unit 201 reads *ID\_2* from ID storage unit 211, transmits a registration request that includes *ID\_2* to AD server 100 via IO unit 215,

and establishes a SAC by the SAC establishment method to be described later.

Control unit 201, on receipt from AD server 100 of a registration failure notification, displays the fact that  
5 registration is not possible on monitor 251, and ends the registration processing.

Control unit 201, on receipt from AD server 100 of encrypted CSI, controls decryption unit 217 to decrypt the encrypted CSI to obtain CSI, and stores the obtained CSI in  
10 CSI storage unit 208. Also, unit 201 transmits a receipt notification to AD server 100 showing that the CSI has been received.

#### *Content Delivery*

On receipt by input unit 213 of an input indicating to  
15 acquire and playback a content, control unit 201 transmits a delivery request to AD server 100.

Control unit 201, on receipt of a delivery failure notification from AD server 100, displays the fact that delivery is not possible on monitor 251, and ends the  
20 processing.

When a received content is to be played, control unit 201, on receipt of encrypted content key *s* from AD server 100, controls decryption unit 217 to decrypt encrypted content key *s* to obtain a content key. Also, on receipt of

an encrypted content from AD server 100, control unit 201 controls decryption unit 220 to decrypt the encrypted content to obtain a content, and has playback unit 221 play the content.

5           *Playback after Accumulating Contents*

On receipt by input unit 213 of an input indicating to acquire and accumulate contents, control unit 201 conducts the same processing as above to acquire contents. Once contents have been acquired, control unit 201 has decryption  
10 unit 217 decrypt encrypted content key *s* received from AD server 100, and controls encryption unit 218 to encrypt the decrypted content key, and stores the encrypted content key in content-key storage unit 219 as encrypted content key *b*. Also, on receipt of encrypted contents from AD server 100,  
15 control unit 201 stores the encrypted contents in content storage unit 209.

On receipt by input unit 213 of an input indicating to playback contents stored in content storage unit 209, control unit 201 controls decryption unit 217 to decrypt encrypted  
20 content key *b*, has decryption unit 220 decrypt the encrypted contents to obtain contents, and has playback unit 221 play the contents.

*Withdrawal*

On receipt by input unit 213 of an input indicating to

start withdrawal processing, control unit 201 establishes a SAC by the SAC establishment method to be described later.

Control unit 201, on receipt of an unregistered notification from AD server 100, displays on monitor 251 the fact that playback apparatus 200 is not registered in AD server 100, and ends the processing.

Control unit 201, on receipt of a deletion notification from AD server 100, deletes CSI stored in CSI storage unit 208, and stores "0" in CSI storage unit 208 showing playback apparatus 200 to be unregistered. Also, control unit 201 transmits a deletion-completed notification that notifies AD server 100 that deletion of the CSI has been completed.

#### *(8) Playback Unit 221*

Playback unit 221 generates video signals from contents received from decryption unit 220, and outputs the generated video signals to monitor 251. Also, unit 221 generates audio signals from received contents, and outputs the generated audio signals to speaker 252.

20

### *1.4 Structure of On-Vehicle Device 300*

As shown in Fig.5, on-vehicle device 300 is structured from a control unit 301, a secret-key storage unit 302, a public-key-certificate storage unit 303, a CRL storage unit

304, a public-key-encryption processing unit 305, a CSI storage unit 308, an ID storage unit 311, a drive unit 312, an input unit 313, an input/output (IO) unit 316, decryption units 317, 318 and 320, a playback unit 321, a monitor 322  
5 and a speaker 323.

On-vehicle device 300 is a computer system the same AD server 100, and a computer program is stored on the RAM or the hard disk unit. On-vehicle device 300 carries out functions as a result of the microprocessor operating in  
10 accordance with the computer program.

*(1) Drive Unit 312, IO Unit 316*

Drive Unit 312 reads encrypted content key *c* from DVD 500, and outputs encrypted content key *c* to decryption unit  
15 318. Also, unit 312 reads an encrypted content and outputs the encrypted content to decryption unit 320.

IO unit 316 conducts transmission/reception of data with IC card 400, under the control of control unit 301.

20 *(2) Secret-Key Storage Unit 302, Public-Key-Certificate Storage Unit 303, CRL Storage Unit 304, CSI Storage Unit 308, ID Storage Unit 311*

CRL storage unit 304 stores the most recent CRL.

ID storage unit 311 stores *ID\_3*, which is the ID unique

to on-vehicle device 300.

CSI storage unit 308 is a tamper-resistant area, and stores "0" showing on-vehicle device 300 to be unregistered. On receipt from IC card 400 of CSI generated by AD server  
5 100, unit 308 stores the received CSI.

Public-key-certificate storage unit 303 stores a PKC *Cert\_3* issued by the CA. PKC *Cert\_3* includes a public key *PK\_3* and *ID\_3* of on-vehicle device 300, and signature data *Sig\_CA3* generated by the CA performing signature algorithm  
10 *S* on public key *PK\_3* and *ID\_3*.

Secret-key storage unit 302 is a tamper-resistant area, and stores a secret key *SK\_3* corresponding to public key *PK\_3*.

### *(3) Public-Key-Encryption Processing Unit 305*

15 Public-key-encryption processing unit 305 conducts authentication with IC card 400, under the control of control unit 301, and establishes a SAC by the SAC establishment method to be described later. Also, unit 305 outputs session key *SK* shared at this time to decryption unit 317.

20

### *(4) Decryption Units 317, 318, 320*

Decryption unit 317, on receipt of encrypted CSI from IC card 400 and under the control of control unit 301, performs decryption algorithm *D* on the encrypted CSI using session

key  $SK$  received from public-key-encryption processing unit 305 to obtain CSI, and outputs the obtained CSI to CSI storage unit 308.

At a time of playing a content, decryption unit 318,  
5 on receipt of encrypted content key  $c$  from drive unit 312,  
reads  $ID\_3$  from ID storage unit 311 and reads CSI from CSI  
storage unit 308. Unit 318 concatenates the read  $ID\_3$  and  
CSI in the stated order to generate decryption key  $c$ . Unit  
318 performs decryption algorithm  $D$  on encrypted content key  
10  $c$  using decryption key  $c$  to obtain a content key, and outputs  
the obtained content key to decryption unit 320.

Decryption unit 320 receives an encrypted content from  
drive unit 312 and a content key from decryption unit 318.  
Unit 320 performs decryption algorithm  $D$  on the encrypted  
15 content using the received content key to obtain a content,  
and outputs the obtained content to playback unit 321.

#### (5) Control Unit 301, Input Unit 313

Control unit 301, when IC card 400 is connected to  
20 on-vehicle device 300, controls public-key-encryption  
processing unit 305 to establish a SAC. At this time, unit  
301 uses the "0" stored in CSI storage unit 308 as CSI. If  
device authentication is unsuccessful, unit 301 ends the  
processing. Also, when a registered notification is received



from IC card 400, unit 301 displays the fact that on-vehicle device 300 is registered on monitor 322, and ends the processing. Unit 301, on receipt of encrypted CSI from IC card 400 via IO unit 316, controls decryption unit 317 to  
5 decrypt the encrypted CSI to obtain CSI, and stores the obtained CSI in CSI storage unit 308. Also, unit 301 transmits a receipt notification to IC card 400 showing that the CSI has been received.

Moreover, copying of CSI from on-vehicle device 300 to  
10 other devices is not conducted.

Control unit 301, on receipt of an input from input unit 313 indicating to view a content recorded on DVD 500, controls drive unit 312 to read encrypted content key  $c$  and an encrypted content from DVD 500. Unit 301 has encrypted content key  $c$   
15 decrypted by decryption unit 318 to obtain a content key, and has the encrypted content decrypted by decryption unit 320 to obtain a content. Also, unit 301 controls playback unit 321 to play the obtained content.

20 (6) *Playback Unit 321, Monitor 322, Speaker 323*

Playback unit 321 generates video signals and audio signals from received contents, outputs the generated video and audio signals to monitor 322 and speaker 323 respectively, and plays the contents.

### 1.3 Structure of IC Card 400

As shown in Fig.6, IC card 400 is structured from a control unit 401, a secret-key storage unit 402, a public-key-certificate storage unit 403, a CRL storage unit 404, a public-key-encryption processing unit 405, a CSI storage unit 408, an ID storage unit 411, an input/output (IO) unit 416, a decryption unit 417, an encryption unit 418, and an ID storage unit 420.

IC card 400 is connectable to AD server 100 and on-vehicle device 300. IC card 400 is used as a device within the authorized domain at a time of registering devices such as on-vehicle device 300 that are not connectable with AD server 100.

15

(1) *Secret-Key Storage Unit 402, Public-Key-Certificate Storage Unit 403, CRL Storage Unit 404, CSI Storage Unit 408, ID Storage Unit 411, ID Storage Unit 420*

CRL storage unit 404 stores the most recent CRL.

20 ID storage unit 411 stores an *ID\_4*, which is an ID unique to IC card 400.

CSI storage unit 408 is a tamper-resistant area, and when a client device has not been registered in AD server 100, stores "0" showing that a client device has yet to be

registered. When CSI is generated by AD server 100, unit 408 stores CSI obtained from AD server 100 in correspondence with "0", which is the copy frequency. Here, the copy frequency is the number of times that copying of CSI to other client  
5 devices is permitted.

Public-key-certificate storage unit 403 stores a PKC *Cert\_4* issued by the CA. PKC *Cert\_4* includes a public key *PK\_4* and *ID\_4* of IC card 400, and signature data *Sig\_CA4* generated by the CA performing signature algorithm *S* on  
10 public key *PK\_4* and *ID\_4*.

Secret-key storage unit 402 is a tamper-resistant area, and stores a secret key *SK\_4* corresponding to public key *PK\_4*.

ID storage unit 420 is an area storing the ID of a CSI copy target.

15

## *(2) Public-Key-Encryption Processing Unit 405*

Public-key-encryption processing unit 405, under the control of control unit 401, establishes a SAC with AD server 100, shares session key *SK*, and outputs the shared session  
20 key *SK* to decryption unit 417.

Also, unit 405 establishes a SAC with on-vehicle device 300 and shares session key *SK*, and outputs the shared session key *SK* to encryption unit 418.

(3) *Decryption Unit 417*

Decryption unit 417, on receipt of encrypted CSI via IO unit 416 and under the control of control unit 401, performs decryption algorithm *D* on the encrypted CSI using session  
5 key *SK* received from public-key-encryption processing unit 405 to obtain CSI, and stores the obtained CSI in CSI storage unit 408.

(4) *Encryption Unit 418*

10 Encryption unit 418, under the control of control unit 401, reads CSI from CSI storage unit 408, receives session key *SK* from public-key-encryption processing unit 405, performs encryption algorithm *E* on the CSI using session key *SK* to generate encrypted CSI, and transmits the encrypted  
15 CSI to on-vehicle device 300.

(5) *Control Unit 401, IO Unit 416*

When IC card 400 is connected to AD server 100, control unit 401 reads *ID\_4* from ID storage unit 411, and transmits  
20 the read *ID\_4* to AD server 100.

At a time of receiving CSI from AD server 100, control unit 401 controls public-key-encryption processing unit 405 to establish a SAC with AD server 100 and share session key *SK*, and on receipt of encrypted CSI, unit 401 has the encrypted

CSI decrypted by decryption unit 417 to obtain CSI, and stores the obtained CSI in CSI storage unit 408.

At a time of registering on-vehicle device 300, control unit 401, on receipt of a permission right from AD server 100, adds "1" to the copy frequency stored in correspondence  
5 100, adds "1" to the copy frequency stored in correspondence with the CSI, and transmits a receipt notification to AD server 100.

When IC card 400 is connected to on-vehicle device 300, control unit 401 controls public-key-encryption processing  
10 unit 405 to establish a SAC, and shares session key *SK*. At this time, unit 401 conducts authentication using the initial value "0" as CSI, and from the authentication result, judges whether on-vehicle device 300 is unregistered. If authentication is unsuccessful, unit 401 judges on-vehicle  
15 device 300 to be registered, transmits a registered notification to on-vehicle device 300, and ends the processing. When authentication is successful, unit 401 judges on-vehicle device 300 to be unregistered, and stores *ID\_3* of on-vehicle device 300 received at the time of  
20 authentication in ID storage unit 420. Unit 401 reads CSI stored in CSI storage unit 408, has the read CSI encrypted by encryption unit 418 to generate encrypted CSI, and transmits the encrypted CSI to on-vehicle device 300. Unit 401, on receipt of a receipt notification from on-vehicle

device 300, subtracts "1" from the copy frequency and ends the processing. Control unit 401, when IC unit 400 is connected to AD server 100, reads *ID\_4* from ID storage unit 411, and transmits the read *ID\_4* to AD server 100. Also, unit 5 401 reads the ID of the CSI copy target from ID storage unit 420, and sends a copy notification that includes the read ID to AD server 100. On receipt from AD server 100 of a receipt notification, unit 401 ends the processing.

## 10 2. Operations of Group Formation/Management System 1

### 2.1 *SAC Operations*

Operations at a time of establishing a SAC will be described using Figs.7 and 8.

Moreover, since this SAC establishment method is used 15 in the mutual authentication of any of AD server 100, playback apparatus 200, on-vehicle device 300, and IC card 400, the devices conducting authentication here are referred to simply as device A and device B. Also, although CSI used in authentication can be "0" showing unregistered or values 20 generated by AD server 100, here it is described simply as "CSI".

Here, *Gen()* is a key generation function and *Y* is a system-unique parameter. Also, key generation function *Gen()* is a function that satisfies a relation  $Gen(x, Gen(Y, z)) =$

$Gen(Y, Gen(x, z))$ . Moreover, since key generation functions are realizable by arbitrary known technology, the details of such functions will not be referred to here. As one example, a Diffie-Hellman (DH) public key delivery method is disclosed  
5 in Nobuichi IKENO, Kenji KOYAMA, *Modern Cryptosystems*, IEICE.

Device A reads PKC *Cert\_A* (step S11), and transmits the read PKC *Cert\_A* to device B (step S12).

Device B, having receiving PKC *Cert\_A*, conducts  
10 signature verification by performing a signature verification algorithm *V* on signature data *Sig\_CA* included in the PKC *Cert\_A*, using a public key *PK\_CA* of the CA (step S13). If verification is unsuccessful (step S14 = NO), device B ends the processing. If verification is successful (step  
15 S14 = YES), device B reads a CRL (step S15), and judges whether *ID\_A* included in the received PKC *Cert\_A* is registered in the CRL (step S16). If judged to be registered (step S16 = YES), device B ends the processing. If judged to be not registered (step S16 = NO), device B reads PKC *Cert\_B* of device  
20 B (step S17), and transmits the read PKC *Cert\_B* to device A (step S18).

Device A, on receipt of PKC *Cert\_B*, conducts signature verification by performing signature verification algorithm *V* on signature data *Sig\_CA* included in the PKC *Cert\_B*, using

public key  $PK_{CA}$  (step S19). If verification is unsuccessful (step S20 = NO), device A ends the processing. If verification is successful (step S20 = YES), device A reads a CRL (step S21), and judges whether  $ID_B$  included in the received PKC  
5  $Cert_B$  is registered in the CRL (step S22). If judged to be registered (step S22 = YES), device A ends the processing. If judged to be not registered (step S22 = NO), device A continues the processing.

Device B generates a random number  $Cha_B$  (step S23),  
10 and transmits generated random number  $Cha_B$  to device A (step S24).

Device A, on receipt of random number  $Cha_B$ , concatenates  $Cha_B$  and CSI in the stated order to generate  $Cha_B \parallel CSI$  (step S25), performs signature algorithm  $S$  on the  
15 generated  $Cha_B \parallel CSI$  using a secret key  $SK_A$  of device A to generate signature data  $Sig_A$  (step S26), and transmits the generated signature data  $Sig_A$  to device B (step S27).

Device B, on receipt of signature data  $Sig_A$ , conducts signature verification by performing signature verification  
20 algorithm  $V$  on the received signature data  $Sig_A$  using  $PK_A$  included in  $Cert_A$  received at step S12 (step S28), and if verification is unsuccessful (step S29 = NO), device B ends the processing, and if successful (step S29 = YES), device B continues the processing.



Device A generates a random number  $Cha\_A$  (step S30), and transmits generated random number  $Cha\_A$  to device B (step S31).

Device B, concatenates the received  $Cha\_A$  and CSI in  
5 the stated order to generate  $Cha\_A \parallel CSI$  (step S32), performs signature algorithm  $S$  on the generated  $Cha\_A \parallel CSI$  using a secret key  $SK\_B$  of device B to generate signature data  $Sig\_B$  (step S33), and transmits the generated signature data  $Sig\_B$  to device A (step S34).

10 Device A, on receipt of signature data  $Sig\_B$ , conducts signature verification by performing signature verification algorithm  $V$  on signature data  $Sig\_B$  using  $PK\_B$  included in  $Cert\_B$  received at step S18 (step S35), and if verification is unsuccessful (step S36 = NO), device A ends the processing.  
15 If successful (step S36 = YES), device A generates a random number "a" (step S37), generates  $Key\_A = Gen(a, Y)$  using generated random number "a" (step S38), and transmits the generated  $Key\_A$  to device B (step S39).

Device B, on receipt of  $Key\_A$ , generates a random number  
20 "b" (step S40), and generates  $Key\_B = Gen(b, Y)$  using generated random number "b" (step S41). Device B transmits the generated  $Key\_B$  to device A (step S42). Also, device B generates  $Key\_AB = Gen(b, Key\_A) = Gen(b, Gen(a, Y))$  using generated random number "b" and the received  $Key\_A$  (step

S43), and generates session key  $SK = \text{Gen}(CSI, \text{Key\_AB})$  using  $\text{Key\_AB}$  and the CSI (step S44).

Device A, on receipt of  $\text{Key\_B}$ , generates  $\text{Key\_AB} = \text{Gen}(a, \text{Key\_B}) = \text{Gen}(a, \text{Gen}(b, Y))$  using generated random number "a" and the received  $\text{Key\_B}$  (step S45), and generates session key  $SK = \text{Gen}(CSI, \text{Key\_AB})$  using the generated  $\text{Key\_AB}$  and the CSI (step S46).

## 2.2 Operations for Playback Apparatus 200 Registration

Operations at a time of AD server 100 registering playback apparatus 200 will now be described using Fig.9.

Moreover, AD server 100 has IC card 400 connected thereto, and has already confirmed that IC card 400 is an IC card affiliated with AD server 100.

Playback apparatus 200, on receipt of an input from input unit 213 indicating to start the registration processing (step S51), reads  $ID\_2$  from ID storage unit 211 (step S52), and transmits a registration request that includes  $ID\_2$  to AD server 100 (step S53).

Given that AD server 100 is device A and playback apparatus 200 is device B, a SAC is established by the above-described method (step S54). At this time, AD server 100 uses "0" as CSI and playback apparatus 200 uses CSI stored in CSI storage unit 208.

AD server 100 conducts the signature verification at step S35 using "0" as CSI, and thus judges playback apparatus 200 to be unregistered if verification is successful, and to be registered if verification is unsuccessful. If playback apparatus 200 is judged to be unregistered, AD server 100 reads registration information (step S55), and judges whether the remaining number is "0" (step S56). If "0" (step S56 = YES), AD server 100 transmits a registration failure notification to playback apparatus 200 (step S57). If the remaining number is not "0" (step S56 = NO), AD server 100 judges whether the registered number is "0" (step S58). If "0" (step S58 = YES), CSI is generated by CSI generation unit 107 (step S59). If the registered number is not "0" (step S58 = NO), AD server 100 reads CSI from CSI storage unit 108 (step S60). Encryption algorithm  $E$  is performed on the generated or read CSI by encryption unit 119 using session key  $SK$ , to generate encrypted CSI (step S61), and AD server 100 transmits the encrypted CSI to playback apparatus 200 (step S62).

Playback apparatus 200, if a registration failure notification is received, displays the fact that registration is not possible on monitor 251 (step S63), and ends the processing. If encrypted CSI is received, the encrypted CSI is decrypted by decryption unit 217 to obtain

CSI (step S64), and playback apparatus 200 stores the CSI in CSI storage unit 208 (step S65). Also, playback apparatus 200 transmits a receipt notification to AD server 100 (step S66).

5           On receipt of the receipt notification from playback apparatus 200, AD server 100 writes *ID\_2* into DEVICE ID in the registration information, adds "1" to the registered number, and subtracts "1" from the remaining number (step S67).

10

### *2.3 Operations for On-vehicle Device 300 Registration*

(1) Operations at a time of permitting the copying of CSI from AD server 100 to IC card 400 will now be described using Fig.10.

15           When IC card 400 is connected to AD server 100, IC card 400 reads *ID\_4* from ID storage unit 411 (step S71), and transmits the read *ID\_4* to AD server 100 (step S72).

AD server 100, on receipt of *ID\_4*, reads an IC card ID from the registration information (step S73), and judges  
20 whether the received ID matches the read ID (step S74). If not matched (step S74 = NO), AD server 100 displays on display unit 114 the fact that the connected IC card is not an IC card affiliated with AD server 100 (step S75) and ends the processing. If matched (step S74 = YES), AD server 100

continues the processing. In this way, AD server 100 confirms whether the connected IC card is an affiliated IC card, and stands by until an input is received once confirmation is completed.

5           On receipt by input unit 113 of an input indicating to permit a copying of CSI to IC card 400 (step S76), control unit 101 reads the remaining number from registration-information storage unit 106 (step S77), judges whether the remaining number is "0" (step S78), and if "0" (step S78 = YES), displays on display unit 114 the fact that  
10 registration is not possible (step S79). If the remaining number is not "0" (step S78 = NO), control unit 101 transmits a permission right to IC card 400 permitting a once-only copying of CSI (step S80).

15           IC card 400, on receipt of the permission right from AD server 100, adds "1" to the copy frequency (step S81), and transmits a receipt notification to AD server 100 (step S82).

AD server 100, on receipt of the receipt notification,  
20 adds "1" to the registered number in the registration information, subtracts "1" from the remaining number (step S83), and ends the processing.

(2) Operations at a time of copying CSI from IC card 400

to on-vehicle 300 will now be described using Fig.11.

When IC card 400 is connected to on-vehicle device 300, the steps S71 to S75 processing is conducted, and IC card 400 is ascertained. Also, IC card 400 and on-vehicle device  
5 300 conducts SAC establishment processing as device A and device B, respectively, and share session key *SK* (step S91). At this time, IC card 400 conducts authentication using "0", which is the initial value of CSI, and on-vehicle device 300 conducts authentication using a value stored in CSI storage  
10 unit 308.

Control unit 401 in IC card 400 conducts the signature verification at step S35 using "0" as CSI, and thus judges on-vehicle device 300 to be unregistered if verification is successful, and to be registered if verification is  
15 unsuccessful. If judged to be registered (step S92 = NO), IC card 400 transmits a registration failure notification to on-vehicle device 300 (step S93), and ends the processing. If judged to be unregistered (step S92 = YES), IC card 400 stores *ID\_3* of on-vehicle device 300 received at step S18  
20 in ID storage unit 420 (step S94). Encryption unit 418, on receipt of session key *SK* from public-key-encryption processing unit 405, reads CSI from CSI storage unit 408 (step S95). Encryption unit 418 encrypts the CSI using session key *SK* to generate encrypted CSI (step S96), and transmits the

encrypted CSI to on-vehicle device 300 via IO unit 416 (step S97).

Control unit 301 in on-vehicle device 300, if a registration failure notification is received from IC card 400, displays the fact that registration is not possible on monitor 322 (step S98), and ends the processing. If encrypted CSI is received from IC card 400, decryption unit 317 receives session key *SK* from public-key-encryption processing unit 305, and decrypts the encrypted CSI using session key *SK* to obtain CSI (step S99), and stores the obtained CSI in CSI storage unit 308 (step S100). Also, control unit 301 transmits a receipt notification to IC card 400 (step S101).

IC card 400, on receipt of the receipt notification from on-vehicle device 300, subtracts "1" from the copy frequency (step S102) and ends the processing.

(3) Operations at a time of notifying AD server 100 of the copying of CSI will now be described.

When IC card 400 is connected to AD server 100, AD server 100 confirms the ID of IC card 400 to confirm that IC card 400 is an affiliated IC card, and stands by until an input is received once confirmation is completed.

IC card 400 reads *ID\_3*, which is the ID of the copy target, from ID storage unit 420, and transmits a copy notification

that includes *ID\_3* to AD server 100.

AD server 100, on receipt of the copy notification, stores *ID\_3* included in the copy notification in the registration information as a device ID. Also, AD server 100  
5 transmits a receipt notification to IC card 400 and ends the processing.

IC card 400, on receipt of the receipt notification from AD server 100, ends the processing.

#### 10 2.4 Content Delivery Operation 1

Operations at a time of delivering a content from AD server 100 to playback apparatus 200 and playing the delivered content will now be described using Fig.12.

Playback apparatus 200, on receipt of an input  
15 indicating to acquire a content from input unit 213 (step S121), transmits a delivery request for a content to AD server 100 (step S122).

AD server 100 and playback apparatus 200 establish a SAC (step S123). At this time, server 100 and device 200  
20 conduct authentication using CSI stored in respective CSI storage units.

AD server 100 confirms that playback apparatus 200 is within the same authorized domain by the processing at step S35.



If authentication is unsuccessful (step S124 = NO), AD server 100 transmits a delivery failure notification to playback apparatus 200 (step S125) and ends the processing. If authentication is successful (step S124 = YES), AD server

5 100 reads encrypted content key *a* from content-key storage unit 118 (step S126), encrypted content key *a* is decrypted by decryption unit 117 (step S127), and furthermore, the content key is encrypted in encryption unit 110 using session key *SK* shared at a time of authentication, to generate

10 encrypted content key *s* (step S128), and AD server 100 transmits encrypted content key *s* to playback apparatus 200 (step S129). Also, AD server 100 reads an encrypted content from content storage unit 109 (step S130), and transmits the encrypted content to playback apparatus 200 (step S131).

15 Playback apparatus 200, in the case of a delivery failure notification being received, displays the fact that delivery is not possible on monitor 251 (step S132) and ends the processing. In the case of encrypted content key *s* being received, encrypted content key *s* is decrypted in decryption

20 unit 217 using session key *SK* to obtain a content key (step S133), and the obtained content key is outputted to decryption unit 220. Decryption unit 220 performs decryption algorithm *D* on the encrypted content received from AD server 100, using the content key received from decryption unit 217,

to obtain a content (step S134), and outputs the obtained content to playback unit 221. Playback unit 221 generates video and audio signals from the received content and outputs the generated video and audio signals respectively to monitor 5 251 and speaker 252, and plays the content (step S135).

## 2.5 Content Delivery Operation 2

Operations at a time of playing contents received from AD server 100 once they have been accumulated will now be 10 described using Fig.13.

The same processing as in steps S121 to S130 is conducted.

Decryption unit 217 decrypts encrypted content key  $s$  to obtain a content key (step S141), and outputs the obtained 15 content key to encryption unit 218. Encryption unit 218 reads CSI from CSI storage unit 208 and  $ID\_2$  from ID storage unit 211 (step S142). Encryption unit 218 concatenates the read  $ID\_2$  and CSI in the stated order to generate  $ID\_2 \parallel CSI$  (step S143), and sets  $ID\_2 \parallel CSI$  as encryption key  $b$ . Encryption unit 20 218 encrypts the content key using the generated encryption key  $b$  to generate encrypted content key  $b$  (step S144), and stores encrypted content key  $b$  in content-key storage unit 219 (step S145). Also, on receipt of an encrypted content from AD server 100, control unit 201 stores the received

encrypted content in content storage unit 209 (step S146).

On receipt from input unit 213 of an input indicating to play a stored content, decryption unit 217 reads encrypted content key  $b$  from content-key storage unit 219 (step S148).

5 Also, decryption unit 217 reads CSI from CSI storage unit 208 and  $ID\_2$  from ID storage unit 211 (step 149), concatenates the read  $ID\_2$  and CSI to generate  $ID\_2 \parallel CSI$  (step S150), and sets  $ID\_2 \parallel CSI$  as a decryption key. Decryption unit 217 performs decryption algorithm  $D$  on encrypted content key  $b$  using the generated decryption key to obtain a content key (step S151), and outputs the obtained content key to decryption unit 220. Decryption unit 220 and playback unit 221 conduct the steps S133 to S135 processing to play the content.

15

## 2.6 Operations at a time of Recording onto DVD

Operation at a time of a content being written to DVD 500 by AD server 100 will now be described using Fig.14.

AD server 100, on receipt from input unit 113 of an input  
20 instructing to record a content onto a DVD (step S161), reads encrypted content key  $a$  from content-key storage unit 118 (step S162), and reads  $ID\_1$  from ID storage unit 111 and CSI from CSI storage unit 108 (step S163). Decryption unit 117 concatenates the read  $ID\_1$  and CSI to generate a decryption

key (step S164), and decrypts encrypted content key *a* using the generated decryption key to obtain a content key (step S165), and outputs the obtained content key to encryption unit 110. Encryption unit 110, on receipt of the content key, reads the device IDs from registration-information storage unit 106 and CSI from CSI storage unit 108 (step S166). Encryption unit 110 concatenates the read *ID\_2* and CSI to generate encryption key *b* and concatenates the read *ID\_3* and CSI to generate encryption key *c* (step S167). Encryption unit 110 encrypts the content key respectively using generated encryption keys *b* and *c* to generate encrypted content keys *b* and *c* (step S168). Control unit 101 writes encrypted content keys *b* and *c* to DVD 500 (step S169). Also, control unit 101 reads an encrypted content from content storage unit 109 (step S170), and writes the encrypted content to DVD 500 (step S171).

## *2.7 Operations for Playback Apparatus 200 Withdrawal*

Operations at a time of playback apparatus 200 withdrawing from AD server 100 will now be described using Fig.15.

Moreover, AD server 100 has IC card 400 connected thereto, and has already confirmed IC card 400.

Playback apparatus 200, on receipt from input unit 213

of an input indicating the withdrawal of playback apparatus 200 (step S181), reads *ID\_2* from ID storage unit 211 (step S182), and transmits a withdrawal request that includes *ID\_2* to AD server 100 (step S183).

5           AD server 100 and playback apparatus 200 conduct authentication and establish a SAC (step S184). At this time, authentication is conducted using CSI stored in respective CSI storage units.

          AD server 100 judges whether playback apparatus 200 is  
10 registered as a device in the authorized domain of AD server 100 by the step S35 processing, and if unregistered (step S185 = NO), transmits an unregistered notification to playback apparatus 200 (step S186). If registered (step S185 = YES), AD server 100 transmits a CSI deletion notification  
15 to playback apparatus 200 (step S187).

          Playback apparatus 200, on receipt of an unregistered notification, displays the fact that playback apparatus 200 is unregistered on monitor 322 (step S188) and ends the processing. On receipt of a deletion notification, playback  
20 apparatus 200 deletes CSI from CSI storage unit 208 (step S189). Also, playback apparatus 200 transmits a deletion-completed notification to AD server 100 (step S190).

          AD server 100, on receipt of the deletion-completed

notification, deletes *ID\_2* from DEVICE ID in the registration information, subtracts "1" from the registered number, and adds "1" to the remaining number (step S191).

### 5    3. Key Delivery Method Variation

Content key delivery in group formation/management system 1 is conducted after group formation. While restrictions are not placed on the delivery time of content keys in the above key delivery method, the following  
10 description relates to a key delivery method in which restrictions are placed on the delivery time of content keys.

Moreover, the system within group formation/management system 1 that conducts key delivery is referred to here as a key delivery system.

15

#### 3.1 *Structure of Key Delivery System 1000*

A structure of key delivery system 1000 will now be described.

As shown in Fig.16, key delivery system 1000 is  
20 structured from a content server 1001, recording medium 1002, playback apparatus 1003, playback apparatus 1004 and gateway (GW) 1007, and forms a single home network. This home network is a group as referred to above. Here, a home network is a network system to which the same subnet is allotted.

GW 1007 is a device that enables communication over a network.

Content server 1001, playback apparatus 1003 and playback apparatus 1004 form a home network via GW 1007, and  
5 are also network-connected to a playback apparatus 1005 by the Internet.

Content server 1001 receives contents from a broadcast station 1006, or acquires contents from a content delivery site over the Internet (not depicted). Here, it is assumed  
10 in the following description that contents are acquired from broadcast station 1006. Content server 1001 generates content keys for encrypting acquired contents, encrypts received contents using the generated content keys to generate encrypted contents, and stores the encrypted  
15 contents in correspondence with information IDs, which are IDs identifying respective encrypted contents. Here, the method used to encrypt contents is common key encryption. This method involves the encryption/decryption of information using the same key and is, as one example, an  
20 Advanced Encryption Standard (AES) algorithm. Since AES algorithms are known technology, a description is omitted here.

Here, no restrictions are placed on the duplication of encrypted contents that have been stored. When encrypted

contents are duplicated, the duplication is conducted in encrypted content/information ID groupings. Moreover, in the present embodiment, playback apparatus 1004 and recording medium 1002 store one or more encrypted contents that have  
5 been generated in content server 1001.

Also, content server 1001 restricts the use of encrypted contents by managing each content key in correspondence with how many of the content key can be delivered (hereafter "deliverable number").

10 Content server 1001, playback apparatus 1004 and recording medium 1002 hold common secret information that is valid only within key delivery system 1000, and when a delivery request for a content key is received, content server 1001 uses this common secret information to conduct  
15 authentication with whichever of playback apparatus 1004 and recording medium 1002 sent the delivery request, and thereby confirms the legitimacy of content key delivery (i.e. judges whether the playback apparatus or recording medium forming the delivery-target is a legitimate device).

20 The authentication method used here is, as one example, a challenge/response handshake using zero knowledge proofs. Since this authentication method is known technology, a description is omitted here. Also, at a time of authentication, secret keys for sharing (referred to as



"shared secret keys") are generated by a known key distribution technique, and the encryption/decryption of information is conducted using these shared secret keys.

If authentication is successful, content server 1001  
5 delivers a content key to the source of the content key delivery request, and subtracts "1" from deliverable number of the content key. At this time, when content key delivery is to be conducted to playback apparatus 1004, content server 1001 delivers first key information formed from a content  
10 key ID, a content key and a corresponding-information ID, and the first key information is stored in playback apparatus 1004. Here, a content key ID is an identifier identifying a content key, and a corresponding-information ID is an information ID corresponding to an encrypted content that  
15 has been encrypted using the content key. Also, when content key delivery is to be conducted to recording medium 1002, content server 1001 delivers second key information formed from a content key ID, a content key, a corresponding-information ID and a usage period, and the  
20 second key information is stored in recording medium 1002. Here, a usage period is information showing a time period during which content key usage is permitted, and is recorded using date-time. Since the content key ID, content key, and corresponding-information ID are the same as above, a

description is omitted here.

Also, content server 1001 receives, over the Internet, a content key delivery request from playback apparatus 1005, which is outside of key delivery system 1000, and conducts authentication with playback apparatus 1005, although in this case authentication is not successful. The reason for this is that playback apparatus 1005, when it has an authentication unit, does not hold the common secret information that is valid only in key delivery system 1000, and so authentication with content server 1001 will always end up being unsuccessful. This is also the case when playback apparatus 1005 does not have an authentication unit, since authentication with content server 1001 cannot be conducted. Also, authentication with content server 1001 will again be unsuccessful for the same reasons in the case of a recording medium that does not hold the common secret information only valid in key delivery system 1000.

Content server 1001, on receipt of information indicating that content key usage has ended, adds "1" to the deliverable number of the content key.

Playback apparatus 1004 stores encrypted contents encrypted in content server 1001, and when an encrypted content is to be used, apparatus 1004 transmits a content key delivery request to content server 1001, conducts

authentication with content server 1001, and if successful,  
acquires first key information from content server 1001,  
decrypts the encrypted content using the content key included  
in the first key information to generate a content, and plays  
5 the generated content. Once playback has ended, playback  
apparatus 1004 deletes the first key information, and  
transmits information to content server 1001 indicating that  
content key usage has ended.

Recording medium 1002 is a portable recording medium  
10 having an internal IC, an example of which is a memory card  
having an internal IC. Recording medium 1002 stores encrypted  
contents encrypted in content server 1001. When an encrypted  
content is to be used, recording medium 1002 is mounted in  
playback apparatus 1003. Playback apparatus 1003, at a time  
15 of encrypted content usage, judges whether second key  
information corresponding to the encrypted content to be used  
exists in recording medium 1002, and if it exists, playback  
apparatus 1003 judges whether the usage period included in  
the second key information has lapsed, and if it has lapsed,  
20 playback apparatus 1003 does not conduct playback. If judged  
to be within the usage period, playback apparatus 1003  
decrypts the encrypted content using the content key included  
in the second key information to generate a content, and plays  
the generated content.

If judged that second key information corresponding to the encrypted content to be used does not exist in recording medium 1002, playback apparatus 1003 transmits a content key delivery request to content server 1001, authentication is  
5 conducted between content server 1001 and recording medium 1002, and if successful, playback apparatus 1003 acquires second key information from content server 1001, and stores the acquired second key information on recording medium 1002. Playback apparatus 1003 decrypts the encrypted content using  
10 the content key included in the second key information stored on recording medium 1002 to generate a content, and plays the generated content.

Also, content server 1001 is able to use encrypted contents stored on recording medium 1002 by the same  
15 operations as playback apparatus 1003. Furthermore, content server 1001 is also able to use encrypted contents stored in content server 1001. In this case, authentication is not conducted at a time of acquiring content keys.

As such, key delivery system 1000 is a system that  
20 manages content keys in content server 1001, and restricts the use of content keys within key delivery system 1000 (i.e. restricts the use of contents).

### *3.2 Structure of Content Server 1001*

The structure of content server 1001 will now be described.

As shown in Fig.17, content server 1001 is structured from content storage unit 1011, a management-information storage unit 1012, a usage-key storage unit 1013, a reception unit 1014, a content acquisition unit 1015, an input unit 1016, a playback unit 1017, a usage-key monitoring unit 1018, a usage-key confirmation unit 1019, a usage-key advance delivery unit 1020, a content-key control unit 1024, an authentication unit 1022, a time management unit 1023, a input/output (IO) unit 1024, a communication unit 1025, and a clocking unit 1026.

Content server 1001 is, specifically, a computer system structured from microprocessor, a ROM, a RAM, a hard disk unit, a network interface and the like. A computer program is stored on the ROM or the hard disk unit. Content server 1001 carries out functions as a result of the microprocessor operating in accordance with the computer program.

#### 20 (1) *Content Storage Unit 1011*

Content storage unit 1011 includes an area for storing encrypted contents in correspondence with information IDs, an example of which is shown in Fig.18.

## (2) *Management-Information Storage Unit 1012*

Management-information storage unit 1012 is tamper resistant, and as shown in Fig.19, includes a key-information storage unit 1031 and a delivered key-information storage  
5 unit 1032.

Key-information storage unit 1031 has a key information table T1001, an example of which is shown in Fig.20. Key information table T1001 includes an area for storing one or more groupings that are each formed from a content key ID,  
10 a content key, a corresponding-information ID, a total number, a remaining number, and a time period restriction. Moreover, each of these groupings is referred to collectively as content key information.

A content key ID is an identifier identifying a content  
15 key.

A content key is a key used in content encryption, and a different content key is used per content.

A corresponding-information ID is an information ID corresponding to an encrypted content encrypted using a  
20 content key. As such, it is possible to correspond content keys with encrypted contents stored in content storage unit 1011.

A "total number" is the sum of the current deliverable number of a content key and the already delivered number of

the content key, and a "remaining number" is the current deliverable number of the content key.

A time period restriction records a time period during which a delivered content key can be used. The time period  
5 may be recorded may be hour-units, or it may be recorded in minute-units, second-units, day-units, or a combination of these. Here, the time period is recorded in hour-units.

Delivered key-information storage unit 1032 has a delivered key information table T1002, an example of which  
10 is shown in Fig.21.

Delivered key information table T1002 includes an area for storing one or more groupings that are each formed from a delivered content key ID and a usage period. Moreover, each of these groupings is referred to collectively as content  
15 key management information.

A delivered content key ID is a content key ID corresponding to a content key delivered to recording medium 1002.

A usage period shows a time period during which a  
20 delivered content key is usable, and is recorded in day-hour-minutes. Moreover, the usage period may be in day-hour-minute-seconds.

### *(3) Usage-Key Storage Unit 1013*

Usage-key storage unit 1013 is tamper-resistant, and stores a content key used in decrypting an encrypted content for use in content server 1001, to generate a content.

5    (4) *Clocking Unit 1026*

Clocking unit 1026 clocks time.

(5) *Reception Unit 1014*

Reception unit 1014 receives contents encrypted for use  
10 in broadcasts, and outputs the encrypted contents to content acquisition unit 1015.

(6) *Content Acquisition Unit 1015*

Content acquisition unit 1015 prestores decryption  
15 keys for decrypting contents encrypted for broadcast usage, and total numbers/time period restrictions relating to content keys deliverable to key delivery system 1000.

Content acquisition unit 1015, on receipt from  
reception unit 1014 of a content encrypted for broadcast  
20 usage, decrypts the encrypted content using a prestored decryption key to generate a content. Next, unit 1015 generates a content key using a random number, and encrypts the content using the content key to generate an encrypted content. Unit 1015 calculates an information ID identifying



the encrypted content, and stores the calculated information ID and the encrypted content in content storage unit 1011.

Furthermore, content acquisition unit 1015 calculates a content key ID identifying the generated content key, generates content key information using the calculated content key ID and information ID, the generated content key and the prestored total number and time period restriction, and writes the generated content key information into key information table T1001. At this point in time, the remaining number is the same as the total number.

#### *(7) Input Unit 1016*

Input unit 1016 receives information relating to content usage, and outputs the received information to playback unit 1017 or usage-key advance delivery unit 1020.

Specifically, input unit 1016 receives, from a user, playback information that includes content storage target information showing whether the storage target of an encrypted content for use is recording medium 1002, and an information ID corresponding to the encrypted content, and outputs the received playback information to playback unit 1017. Here, "0" and "1" are used as content storage target information. "0" shows that the storage target of an encrypted content for use is recording medium 1002. "1" shows

that the storage target is other than recording medium 1002.  
In the given example, "1" shows that the storage target of  
the encrypted content is content server 1001.

Input unit 1016, on receipt of playback stoppage  
5 information from a user indicating to stop content playback,  
outputs the received playback stoppage information to  
playback unit 1017.

Also, input unit 1016 receives, from a user, advance  
request information requesting advance delivery of a content  
10 key to recording medium 1002, and outputs the received  
advance request information to usage-key confirmation unit  
1019. Here, advance request information is information that  
includes the information ID of an encrypted content  
corresponding to a content key whose advance delivery is  
15 requested.

#### (8) *Playback Unit 1017*

Playback unit 1017 decrypts encrypted contents stored  
in content storage unit 1011 to generate contents and plays  
20 the generated contents, or decrypts contents stored on  
recording medium 1002 to generate contents and plays the  
generated contents.

Specifically, playback unit 1017 receives playback  
information from input unit 1016, and judges whether the

storage target of an encrypted content for use is recording medium 1002, using content storage target information included in the received playback information.

When the storage target of the encrypted content is judged to be recording medium 1002, playback unit 1017 outputs the received playback information to usage-key confirmation unit 1019.

When judged that the storage target of the encrypted content is other than recording medium 1002 (i.e. content server 1001), playback unit 1017 outputs the received playback information to usage-key monitoring unit 1018.

Playback unit 1017 receives, from usage-key monitoring unit 1018 or usage-key confirmation unit 1019, key-acquisition completed information that includes storage target information showing whether the storage target of a content key is recording medium 1002. Here, "0" and "1" are used as key storage target information. "0" shows that the storage target of a content key is recording medium 1002. "1" shows that the storage target is other than recording medium 1002. In the given example, "1" shows that the content key storage target is content server 1001.

Playback unit 1017 judges whether the content key storage target is recording medium 1002, using the key storage target information included in the received

key-acquisition completed information.

When the content key storage target is judged to be recording medium 1002, playback unit 1017 acquires a content key from recording medium 1002 via IO unit 1024, and  
5 furthermore acquires, from recording medium 1002 via IO unit 1024, an encrypted content corresponding to the information ID included in the playback information received from input unit 1016, decrypts the encrypted content using the acquired content key to generate a content, and plays the generated  
10 content.

When the content key storage target is judged to be other than recording medium 1002 (i.e. content server 1001), playback unit 1017 acquires the content key included in the first key information stored in usage-key storage unit 1013,  
15 and furthermore acquires, from content storage unit 1011, an encrypted content corresponding to the information ID included in the playback information received from input unit 1016, decrypts the encrypted content using the received content key to generate a content, and plays the generated  
20 content.

Also, playback unit 1017, on receipt from input unit 1016 of playback stoppage information, stops playback of the content currently being played.

(9) *Usage-Key Monitoring Unit 1018*

Usage-key monitoring unit 1018 stores, in usage-key storage unit 1013, first key information used in playback unit 1017 when an encrypted content stored in content storage unit 1011 is to be used, and deletes stored first key information when usage of the encrypted content ends.

Specifically, usage-key monitoring unit 1018, on receipt of playback information from playback unit 1017, generates first request information, and outputs the generated first request information to content-key control unit 1021. Here, first request information is information indicating to store a content key in usage-key storage unit 1013, and includes the information ID included in the playback information.

Usage-key monitoring unit 1018 receives first key information from content-key control unit 1021, stores the received first key information in usage-key storage unit 1013, generates key-acquisition completed information in which the key storage target information is "1", and outputs the generated key-acquisition completed information to playback unit 1017.

Furthermore, usage-key monitoring unit 1018 monitors the operations of playback unit 1017, and when detecting the end of content playback or the end of operations by playback

unit 1017 due to a content playback stoppage, deletes the first key information stored in usage-key storage unit 1013, generates key-usage ended information showing that content key usage has ended, and outputs the generated key-usage  
5 ended information to content-key control unit 1021. Here, key-usage ended information includes the information ID corresponding to the encrypted content that was used.

*(10) Usage-Key Confirmation Unit 1019*

10        Usage-key confirmation unit 1019 confirms the usage period of content keys stored on recording medium 1002, and records/deletes content keys.

Specifically, usage-key confirmation unit 1019, on receipt of playback information from playback unit 1017,  
15 judges whether there exists second key information corresponding to the information ID included in the received playback information.

If judged that corresponding second key information exists, usage-key confirmation unit 1019 acquires the  
20 present date-time from clocking unit 1026, and judges whether the usage period of the content key included in the second key information has lapsed. If judged to be within the usage period, unit 1019 generates key-acquisition completed information in which the key storage information is "0", and

outputs the generated key-acquisition completed information to playback unit 1017. If judged that the usage period has lapsed, unit 1019 deletes the second key information and notifies usage-failure information to the user, showing that  
5 usage of the content key is not possible.

If judged that corresponding second key information does not exist, usage-key confirmation unit 1019 generated second request information, and outputs the generated second request information to content-key control unit 1021. Also,  
10 unit 1019 outputs, to recording medium 1002 via IO unit 1024, information indicating that playback information has been received. Here, second request information is information indicating to output a content key to recording medium 1002, and includes the information ID included in the playback  
15 information.

Usage-key confirmation unit 1019 receives encrypted second key information from content-key control unit 1021, and outputs the encrypted second key information to recording medium 1002 via IO unit 1024. Furthermore, unit 1019  
20 generates key-acquisition completed information in which the key storage information is "0", and outputs the generated key-acquisition completed information to playback unit 1017.

(11) *Usage-Key Advance Delivery Unit 1020*

Usage-key advance delivery unit 1020 conducts advance delivery of content keys to recording medium 1002.

Specifically, usage-key advance delivery unit 1020, on receipt of advance request information, outputs the received  
5 advance request information to content-key control unit 1021, and furthermore outputs, to recording medium 1002 via IO unit 1024, information indicating that the advance request information has been received.

Usage-key advance delivery unit 1020 receives, from  
10 content-key control unit 1021, encrypted second key information, and outputs the encrypted second key information to recording medium 1002 via IO unit 1024.

#### (12) *Content-Key Control Unit 1021*

15 Content-key control unit 1021 manages content keys to be delivered.

Specifically, content-key control unit 1021 receives first request information, second request information, third request information indicating to conduct content key  
20 delivery using a network, or advance request information. Furthermore, unit 1021 receives key-usage ended information from usage-key monitoring unit 1018, or from playback apparatus 1004 via communication unit 1025.

Here, third request information includes a usage



classification and an information ID corresponding to an encrypted content. Also, in the usage classification is recorded either information showing "playback apparatus" or information showing "recording medium". When the usage  
5 classification is information showing "playback apparatus", this shows that a content for use is recorded on a playback apparatus, and when the usage classification is information showing "recording medium", this shows that a content for use is recorded onto a recording medium. Moreover,  
10 content-key control unit 1021 receives the third request information from playback apparatus 1005.

Content-key control unit 1021 judges whether the received information is key-usage ended information.

If judged to not be key-usage ended information,  
15 content-key control unit 1021 further judges whether the received information is first request information.

If judged to be first request information, content-key control unit 1021 acquires, from key information table T1001 using the information ID in the first request information,  
20 content key information that includes a corresponding-information ID matching the information ID. Unit 1021 judges whether the remaining number in the acquired content key information is "0". If judged to be "0", unit 1021 notifies none-remaining information to the user

indicating that the remaining deliverable number of the content key is "0". If judged to not be "0", unit 1021 generates first key information from the acquired content key information, and outputs the generated first key information to usage-key monitoring unit 1018. Furthermore, unit 1021 subtracts "1" from the remaining number in the acquired content key information to update the content key information, and writes the updated content key information into key information table T1001.

10        If judged to not be first request information, content-key control unit 1021 outputs authentication identifying information to authentication unit 1022 showing that the received information is one of second request information, third request information whose usage classification is "playback apparatus", third request information whose usage classification is "recording medium", and advance request information.

Content-key control unit 1021, on receipt of authentication-succeeded information from authentication unit 1022 indicating that authentication was successful, acquires and delivers a content key, and updates key information table T1001, as described below.

Content-key control unit 1021 judges whether the received information is one of second request information,

third request information, and advance request information.

If judged to be second request information, content-key control unit 1021, the same as with first request information, acquires content key information using the information ID  
5 included in the second request information, and judges whether the remaining number in the acquired content key information is "0". If judged to be "0", unit 1021 notifies none-remaining information to the user indicating that the remaining deliverable number of the content key is "0". If  
10 judged to not be "0", unit 1021 furthermore acquires the present date-time from clocking unit 1026, and calculates a usage period using the acquired date-time and the time period restriction information included in the content key information. Unit 1021 generates second key information from  
15 the calculated usage period and the acquired content key information, encrypts the generated second key information using the shared secret key generated at the time of authentication, and outputs the encrypted second key information to usage-key confirmation unit 1019. Furthermore,  
20 unit 1021 subtracts "1" from the remaining number in the acquired content key information to update the content key information, and writes the updated content key information into key information table T1001. Also, unit 1021 generates content key management information from the calculated usage

period and the acquired content key information, and writes the generated content key management information into delivered key information table T1002:

If judged that the received information is third  
5 request information, content-key control unit 1021, the same as with first request information, acquires content key information using the information ID included in the third request information, and judges whether the remaining number in the acquired content key information is "0". If judged  
10 to be "0", unit 1021 notifies none-remaining information to the user indicating that the remaining deliverable number of the content key is "0". If judged to not be "0", unit 1021 furthermore judges whether the usage classification included in the third request information shows "playback apparatus"  
15 or "recording medium".

If judged that the usage classification shows "playback apparatus", content-key control unit 1021 generates first key information, encrypts the generated first key information using the shared secret key generated at the time  
20 of authentication, and outputs the encrypted first key information to playback apparatus 1004 via communication unit 1025. Furthermore, unit 1021 subtracts "1" from the remaining number in the acquired content key information to update the content key information, and writes the updated

content key information into key information table T1001.

If judged that the usage classification shows "recording medium", content-key control unit 1021 furthermore acquires the present date-time from clocking  
5 unit 1026, calculates a usage period using the acquired date-time and time period restriction information included in the content key information, generates second key information from the calculated usage period and the acquired content key information, encrypts the generated second key  
10 information using the shared secret key generated at the time of authentication, and outputs the encrypted second key information via communication unit 1025 to recording medium 1002 mounted in playback apparatus 1003. Furthermore, unit 1021 subtracts "1" from the remaining number in the acquired  
15 content key information to update the content key information, and writes the updated content key information into key information table T1001. Also, unit 1021 generates content key management information from the calculated usage period and the acquired content key information, and writes the  
20 generated content key management information into delivered key information table T1002.

If judged that the received information is advance request information, content-key control unit 1021 acquires, from key information table T1001 using the information ID

in the advance request information, content key information that includes a corresponding-information ID matching the information ID, and judges whether the remaining number in the acquired content key information is "0". If judged to be "0", unit 1021 notifies none-remaining information to the user indicating that the remaining deliverable number of the content key is "0". If judged to not be "0", unit 1021 furthermore acquires the present date-time from clocking unit 1026, calculates a usage period using the acquired date-time and time period restriction information included in the content key information, generates second key information from the calculated usage period and the acquired content key information, encrypts the generated second key information using the shared secret key generated at the time of authentication, and outputs the encrypted second key information to usage-key advance delivery unit 1020. Furthermore, unit 1021 subtracts "1" from the remaining number in the acquired content key information to update the content key information, and writes the updated content key information into key information table T1001. Also, unit 1021 generates content key management information from the calculated usage period and the acquired content key information, and writes the generated content key management information into delivered key information table T1002.

Content-key control unit 1021, when judged that the received information is key-usage ended information, acquires, from key information table T1001 using the information ID included in the received key-usage ended  
5 information, content key information that includes a corresponding-information ID matching the information ID. Unit 1021 adds "1" to the remaining number in the acquired content key information to update the content key information, and writes the updated content key information into key  
10 information table T1001.

(13) *Authentication Unit 1022*

Authentication unit 1022 prestores common secret information, and conducts authentication with playback  
15 apparatus 1004, and with recording medium 1002 when mounted in either content server 1001 or playback apparatus 1003.

Specifically, authentication unit 1022, on receipt of authentication identifying information from content-key control unit 1021, conducts authentication using the  
20 received authentication identifying information, as described below.

If judged that the authentication identifying information shows second request information or advance request information, authentication unit 1022 conducts

authentication mutually with recording medium 1002 mounted in content server 1001.

If judged that the authentication identifying information shows third request information whose usage  
5 classification is "playback apparatus", authentication unit 1022 conducts authentication mutually with playback apparatus 1004, and if judged to show third request information whose usage classification is "recording medium", unit 1022 conducts authentication mutually with recording  
10 medium 1002 mounted in playback apparatus 1003.

Moreover, authentication unit 1022 generates a shared secret key when commencing the authentication, encrypts information for use in the authentication using the shared secret key, transmits the encrypted information to playback  
15 apparatus 1004 or recording medium 1002, and also receives encrypted information from playback apparatus 1004 or recording medium 1002, decrypts the encrypted information, and uses the decrypted information in the authentication.

Authentication unit 1022 judges whether authentication  
20 was successful, and if successful, outputs authentication-succeeded information to content-key control unit 1021, and if unsuccessful, notifies authentication-failed information to the user indicating that authentication was not successful.



(14) *Time Management Unit 1023*

Time management unit 1023 manages usage periods corresponding to delivered content key IDs recorded in delivered key information table T1002, using clocking unit 1026.

Specifically, time management unit 1023 judges using clocking unit 1026 whether usage periods corresponding to delivered content key IDs recorded in delivered key information table T1002 have lapsed. If judged that a usage period has lapsed, unit 1023 deletes the corresponding content key management information, acquires, from key information table T1001, content key information that matches the delivered content key ID that has been deleted, adds "1" to the remaining number in the acquired content key information to update the content key information, and writes the updated content key information into key information table T1001.

20 (15) *IO Unit 1024*

IO unit 1024 receives information from recording medium 1002 mounted in content server 1001, and outputs the received information to playback unit 1017, usage-key confirmation unit 1019, usage-key advance delivery unit 1020,

authentication unit 1022.

Also, IO unit 1024 outputs information received from playback unit 1017, usage-key confirmation unit 1019, usage-key advance delivery unit 1020, authentication unit  
5 1022 to recording medium 1002 mounted in content server 1001.

#### (16) *Communication Unit 1025*

Communication unit 1025 transmits information received from content-key control unit 1021 to playback apparatus 1004  
10 or to recording medium 1002 mounted in playback apparatus 1003, and transmits information received from authentication unit 1022 to playback apparatus 1004; recording medium 1002 mounted in playback apparatus 1003, or playback apparatus 1005.

15 Also, communication unit 1025 outputs information received from playback apparatus 1004, recording medium 1002 mounted in playback apparatus 1003, or playback apparatus 1005 to content-key control unit 1021 or authentication unit 1022.

20

### 3.3 *Structure of Recording Medium 1002*

The structure of recording medium 1002 will now be described.

As shown in Fig.22, recording medium 1002 is structured

from a content storage unit 1101, a usage-key storage unit 1102, an authentication unit 1103, and an input/output (IO) unit 1104.

Recording medium 1002 is, specifically, a computer system structured from microprocessor, a ROM, a RAM, and the like. A computer program is stored on the ROM. recording medium 1002 carries out functions as a result of the microprocessor operating in accordance with the computer program.

#### (1) *Content Storage Unit 1101*

Content storage unit 1101 includes an area the same as content storage unit 1011 in content server 1001.

#### (2) *Usage-Key Storage Unit 1102*

Usage-key storage unit 1102 is tamper-resistant, and includes a delivered content key table T1101, an example of which is shown in Fig.23.

Since the various items in delivered content key table T1101 are the same as the data structuring the second key information, a description is omitted here.

#### (3) *Authentication Unit 1103*

Authentication unit 1103 prestores common secret

information, and conducts authentication with authentication unit 1022 included in content server 1001.

Specifically, authentication unit 1103 conducts authentication mutually with content server 1001 by  
5 receiving, from content server 1001 via IO unit 1104, information indicating that playback information or advance request information has been received, or by receiving, from playback apparatus 1003 via IO unit 1104, information indicating that playback information has been received.

10 Authentication unit 1103 judges whether authentication was successful, and if successful, outputs authentication-succeeded information to playback apparatus 1003 via IO unit 1104, and if not successful, notifies authentication-failed information to the user.

15 Also, authentication unit 1103, the same as authentication unit 1022 in content server 1001, generates common secret information when commencing the authentication. Unit 1103 encrypts information for use in the authentication, using the generated common secret information, transmits the  
20 encrypted information to content server 1001, and also receives encrypted information from content server 1001, decrypts the encrypted information, and used the decrypted information in the authentication.

(4) IO Unit 1104

IO unit 1104 receives information from an apparatus in which recording medium 1002 is mounted. Unit 1104 judges whether the received information is information relating to authentication, an encrypted content, or encrypted second key information.

If judged to be information relating to authentication, IO unit 1104 outputs the received information to authentication unit 1103, and if judged to be an encrypted content, unit 1104 writes the encrypted content into content storage unit 1101. If judged to be encrypted second key information, unit 1104 decrypts the encrypted second key information using the common secret information generated at the time of authentication to generate second key information, and writes the generated second key information into usage-key storage unit 1102.

Also, IO unit 1104 outputs information received from content storage unit 1101, usage-key storage unit 1102 or authentication unit 1103 to the apparatus in which recording medium 1002 is mounted.

### 3.4 Structure of Playback Apparatus 1003

The structure of playback apparatus 1003 will now be described.

As shown in Fig.24, playback apparatus 1003 is structure from an input unit 1201, a playback unit 1202, a usage-key confirmation unit 1203, an input/output (IO) unit 1204, a communication unit 1205, and a clocking unit 1206.

5 Playback apparatus 1003 is, specifically, a computer system structured from microprocessor, a ROM, a RAM, a hard disk unit, a network interface, and the like. A computer program is stored on the ROM or the hard disk unit. Playback apparatus 1003 carries out functions as a result of the  
10 microprocessor operating in accordance with the computer program.

*(1) Clocking Unit 1206*

Clocking unit 1206 clocks date-time.

15

*(2) Input Unit 1201*

Input unit 1201 receives information relating to content usage, and outputs the received information to playback unit 1202.

20 Specifically, input unit 1201 receives playback information from a user, and outputs the received playback information to playback unit 1202. Here, the content storage target information included in the playback information is always "0".

Input unit 1201, on receipt from a user of playback stoppage information indicating to stop content playback, outputs the received playback stoppage information to playback unit 1202.

5

*(3) Playback Unit 1202*

Playback unit 1202 decrypts encrypted contents stored on recording medium 1002 to generate contents, and plays the generated contents.

10       Specifically, playback unit 1202, on receipt from input unit 1201 of playback information, outputs the received playback information to usage-key confirmation unit 1203.

Playback unit 1202, on receipt of key-acquisition completed information from usage-key confirmation unit 1203,  
15       acquires a content key from recording medium 1002, and furthermore acquires, from content storage unit 1101 in recording medium 1002, an encrypted content corresponding to the information ID included in the playback information received from input unit 1201, decrypts the encrypted content  
20       using the acquired content key to generate content, and plays the generated content.

Also, playback unit 1202, on receipt of playback stoppage information from input unit 1201, stops playback of the content currently being played.

#### (4) Usage-Key Confirmation Unit 1203

Usage-key confirmation unit 1203 confirms the usage periods of content keys stored in recording medium 1002, and  
5 records/deletes content keys.

Specifically, usage-key confirmation unit 1203, on receipt of playback information from playback unit 1202, judges whether there exists second key information in recording medium 1002 that corresponds to the information  
10 ID included in the received playback information.

If judged that corresponding second key information exists, usage-key confirmation unit 1203 acquires the present date-time from clocking unit 1206, and judges whether the usage period of the content key included in the second  
15 key information has lapsed. If judged to be within the usage period, unit 1203 generates key-acquisition completed information in which the key storage target information is "0", and outputs the generated key-acquisition completed information to playback unit 1202. If judged that the usage  
20 period has lapsed, unit 1203 deletes the second key information, and notifies usage-failure information to the user showing that content key usage is not possible.

If judged that corresponding second key information does not exist, usage-key confirmation unit 1203 generates



third request information that includes a usage classification showing "recording medium" and the information ID from the received playback information, and outputs the generated third request information to content  
5 server 1001. Also, unit 1203 outputs, to recording medium 1002 via IO unit 1024, information indicating that the playback information has been received.

Usage-key confirmation unit 1203, on receipt of authentication-succeeded information from authentication  
10 unit 1103 via IO unit 1204, furthermore receives encrypted second key information from content server 1001 via communication unit 1205, and outputs the encrypted second key information to recording medium 1002 via IO unit 1204. Furthermore, unit 1203 generates key-acquisition completed  
15 information in which the key storage target information is "0", and outputs the generated key-acquisition completed information to playback unit 1202.

#### (5) IO Unit 1204

20 IO unit 1204 outputs information received from recording medium 1002 to playback unit 1202, usage-key confirmation unit 1203, or communication unit 1205.

Also, IO unit 1204 outputs information received from playback unit 1202, usage-key confirmation unit 1203, or

communication unit 1205 to recording medium 1002.

(6) *Communication Unit 1205*

Communication unit 1205 outputs information received  
5 from content server 1001 to usage-key confirmation unit 1203  
or IO unit 1204.

Also, communication unit 1205 transmits information  
received from usage-key confirmation unit 1203 and IO unit  
1204 to content server 1001.

10

3.5 *Structure of Playback Apparatus 1004*

The structure of playback apparatus 1004 will now be  
described.

As shown in Fig.25, playback apparatus 1004 is  
15 structure from a content storage unit 1301, a usage-key  
storage unit 1302, an input unit 1303, a playback unit 1304,  
a usage-key monitoring unit 1305, an authentication unit 1306,  
and a communication unit 1307.

Playback apparatus 1004 is, specifically, a computer  
20 system structured from microprocessor, a ROM, a RAM, a hard  
disk unit, a network interface, and the like. A computer  
program is stored on the ROM or the hard disk unit. Playback  
apparatus 1004 carries out functions as a result of the  
microprocessor operating in accordance with the computer

program.

(1) *Content Storage Unit 1301*

Content storage unit 1301 includes an area the same as  
5 content storage unit 1011 in content server 1001.

(2) *Usage-Key Storage Unit 1302*

Usage-key storage unit 1302 is tamper-resistant, and  
stores content keys used in decrypting encrypted content for  
10 use in playback apparatus 1004, to generate contents.

(3) *Input Unit 1303*

Input unit 1303 receives information relating to  
content usage, and outputs the received information to  
15 playback unit 1304.

Specifically, input unit 1303 receives playback  
information from a user, and outputs the received playback  
information to playback unit 1304. Here, the content storage  
target information included in the playback information is  
20 always "1".

Input unit 1303, on receipt from a user of playback  
stoppage information indicating to stop content playback,  
outputs the received playback stoppage information to  
playback unit 1304.

(4) *Playback Unit 1304*

Playback unit 1304 decrypts encrypted contents stored in content storage unit 1301 to generate contents, and plays  
5 the generated contents.

Specifically, playback unit 1304, on receipt of playback information from input unit 1303, outputs the received playback information to usage-key monitoring unit 1305.

10 Playback unit 1304, on receipt of key-acquisition completed information from usage-key monitoring unit 1305, acquires the content key included in the first key information from usage-key storage unit 1302, and furthermore acquires, from content storage unit 1301, an  
15 encrypted content corresponding to the information ID included in the playback information received input unit 1303, decrypts the encrypted content using the acquired content key to generate a content, and plays the generated content.

Also, playback unit 1304, on receipt of playback  
20 stoppage information from input unit 1303, stops playback of the content currently being played.

(5) *Usage-Key Monitoring Unit 1305*

Usage-key monitoring unit 1305 stores, in usage-key

storage unit 1302, content keys to be used when encrypted contents stored in content storage unit 1301 are used in playback unit 1304, and deletes stored content keys when usage of encrypted contents has ended.

5           Specifically, usage-key monitoring unit 1305, on receipt of playback information from playback unit 1304, generates third request information that includes a usage classification showing "playback apparatus" and the information ID included in the received playback information,  
10       outputs the generated third request information to content server 1001, and furthermore outputs information to authentication unit 1306 indicating that the playback information has been received.

          Usage-key monitoring unit 1305, on receipt of  
15       authentication-succeeded information from authentication unit 1306, furthermore receives encrypted first key information from content server 1001 via communication unit 1307. Unit 1305 decrypts the encrypted first key information using the shared secret key generated at the time of  
20       authentication to generate first key information, and stores the generated first key information in usage-key storage unit 1302. Furthermore, unit 1305 generates key-acquisition completed information in which the key storage target information is "1", and outputs the generated

key-acquisition completed information to playback unit 1304.  
In this case, if the key storage target information is "1",  
this shows that the content key storage target is usage-key  
storage unit 1302 in playback apparatus 1004.

5           Furthermore, usage-key monitoring unit 1305 monitors  
the operations of playback unit 1304, and on detecting that  
content playback has ended or that the operations of playback  
unit 1304 have ended due to a content playback stoppage (i.e.  
on detecting that content usage has ended), deletes the first  
10 key information stored in usage-key storage unit 1302,  
generates key-usage ended information, and outputs the  
generated key-usage ended information to content server  
1001.

15   (6) *Authentication Unit 1306*

Authentication unit 1306 prestores common secret  
information, and conducts authentication with  
authentication unit 1022 included in content server 1001.

Specifically, authentication unit 1306 conducts  
20 authentication mutually with content server 1001 by  
receiving information from usage-key monitoring unit 1305  
indicating that playback information has been received.

Authentication unit 1306 judges whether authentication  
was successful, and if successful, outputs

authentication-succeeded information to usage-key monitoring unit 1305, and if not successful, notifies authentication-failed information to the user indicating that authentication was not successful.

5        Also, authentication unit 1306, the same as authentication unit 1022 in content server 1001, generates a shared secret key when commencing the authentication. Unit 1306 encrypts information for use in the authentication using the shared secret key, transmit the encrypted information  
10 to content server 1001, and also receives encrypted information from content server 1001, decrypts the encrypted information, and uses the decrypted information in the authentication.

15    (7) *Communication Unit 1307*

Communication unit 1307 outputs information received from content server 1001 to usage-key monitoring unit 1305 or authentication unit 1306.

Also, communication unit 1307 outputs information  
20 received from usage-key monitoring unit 1305 or authentication unit 1306 to content server 1001.

### 3.6 *Operations of Key Delivery System 1000*

The operations of key delivery system 1000 will now be

described.

*(1) Content Key Management Processing Operations*

The content key management processing conducted in  
5 content server 1001 by content-key control unit 1021 and  
authentication unit 1022 will now be described using the  
Figs.26 and 27 flowcharts.

Content-key control unit 1021 receives information  
(step S1000), and judges whether the received information  
10 is key-usage ended information (step S1005).

If judged at step S1005 to be key-usage ended  
information, content-key control unit 1021, using the  
information ID included in the received key-usage ended  
information, adds "1" to the remaining number in content key  
15 information corresponding to the information ID, to update  
key information table T1001 (step S1010).

If judged at step S1005 to not be key-usage ended  
information, content-key control unit 1021 judges whether  
the received information is first request information (step  
20 S1015).

If judged at step S1015 to be first request information,  
content-key control unit 1021 acquires content key  
information corresponding to the information ID included in  
the first request information, and judges whether the



remaining number in the acquired content key information is "0" (step S1020).

If judged at step S1020 to be "0", content-key control unit 1021 generates first key information from the acquired content key information, and outputs the generated first key  
5 information to usage-key monitoring unit 1018 (step 1025). Furthermore, unit 1021 subtracts "1" from the remaining number in the acquired content key information to update key information table T1001 (step S1030).

10 If judged at step S1020 that the remaining number is "0", content-key control unit 1021 notifies none-remaining information to the user (step S1135).

If judged at step S1015 to not be first request information, content-key control unit 1021 outputs  
15 authentication identifying information to authentication unit 1022 and authentication processing is conducted in authentication unit 1022 with the source of the content key delivery request (step S1035). Authentication unit 1022 judges whether the authentication processing at step S1035  
20 was successful (step S1040). If judged at step S1040 that authentication was not successful, unit 1021 notifies authentication-failed information to the user (step S1045).

If judged at step S1040 that authentication was successful, content-key control unit 1021 judges whether the

received information is second request information (step S1050).

If judged at step S1050 to be second request information, content-key control unit 1021 acquires content key information corresponding to the information ID included in the second request information, and judges whether the remaining number in the acquired content key information is "0" (step S1055).

If judged at step S1055 that the remaining number is not "0", content-key control unit 1021 generates second key information from the acquired content key information, encrypts the generated second key information, and outputs the encrypted second key information to usage-key confirmation unit 1019 (step S1060). Furthermore, unit 1021 subtracts "1" from the remaining number in the acquired content key information to update key information table T1001 (step S1065). Also, unit 1021 generates content key management information, and writes the generated content key management information into delivered key information table T1002 (step S1070).

If judged at step S1055 that the remaining number is "0", content-key control unit 1021 notifies none-remaining information to the user (step S1135).

If judged at step S1050 to not be second request

information, content-key control unit 1021 judges whether the received information is third request information (step S1075).

If judged at step S1075 to be third request information,  
5 content-key control unit 1021 acquires content key information corresponding to the information ID included in the third request information, and judges whether the remaining number in the acquired content key information is "0" (step S1080).

10 If judged at step S1080 that the remaining number is not "0", content-key control unit 1021 judges whether the usage classification included in the received third request information is information showing "playback apparatus" (step S1085).

15 If judged at step S1085 to be information shows "playback apparatus", content-key control unit 1021 generates first key information from the acquired content key information, encrypts the generated first key information, and transmits the encrypted first key  
20 information to playback apparatus 1004 (step S1090). Furthermore, unit 1021 subtracts "1" from the remaining number in the acquired content key information to update key information table T1001 (step S1065).

If judged at step S1085 to not be information showing

"playback apparatus", content-key control unit 1021 generates second key information from the acquired content key information, encrypts the generated second key information, and transmits the encrypted second key information to recording medium 1002 (step S1100). Furthermore, unit 1021 subtracts "1" from the remaining number in the acquired content key information to update key information table T1001 (step S1105). Also, unit 1021 generates content key management information, and writes the generated content key management information into delivered key information table T1002 (step S1110).

If judged at step S1080 that the remaining number is "0", content-key control unit 1021 notifies none-remaining information to the user (step S1135).

If judged at step S1075 to not be third request information (i.e. when judged that the received information is advance request information), content-key control unit 1021 acquires content key information corresponding to the information ID included in the received advance request information, and judges whether the remaining number in the acquired content key information is "0" (step S1115).

If judged at step S1115 that the remaining number is not "0", content-key control unit 1021 generates second key information from the acquired content key information,

encrypts the generated second key information, and outputs the encrypted second key information to usage-key advance delivery unit 1020 (step 1120). Furthermore, unit 1021 subtracts "1" from the remaining number in the acquired  
5 content key information to update key information table T1001 (step 1125). Also, unit 1021 generates content key management information, and writes the generated content key management information into delivered key information table T1002 (step S1130).

10        If judged at step S1115 that the remaining number is "0", content-key control unit 1021 notifies none-remaining information to the user (step S1135).

## *(2) Authentication Processing Operations*

15        Authentication processing, which is conducted as part of the content key management processing, will now be described using the Fig.28 flowchart.

Authentication unit 1022, on receipt of authentication identifying information from content-key control unit 1021,  
20 judges whether the received authentication identifying information shows second request information or advance request information (step S1150).

If judged to show second request information or advance request information, authentication unit 1022 conducts

mutual authentication with recording medium 1002 mounted in content server 1001 (step S1155).

If the received authentication identifying information is judged at step S1150 to not be information showing second  
5 request information or advance request information, authentication unit 1022 judges whether it is third request information whose usage classification is "playback apparatus" (step S1160).

If judged to show third request information whose usage  
10 classification is "playback apparatus", authentication unit 1022 conducts authentication mutually with playback apparatus 1004 (step S1165), and if judged to not be third request information whose usage classification is "playback apparatus" (i.e. judged to be third request information whose  
15 "usage classification is "recording medium"), authentication unit 1022 conducts authentication mutually with recording medium 1002 mounted in playback apparatus 1003 (step S1170).

### 20 (3) *Time Management Processing Operations*

Time management processing conducted in time management unit 1023 of content server 1001 will now be described using the Fig.29 flowchart.

Time management unit 1023 acquires content key

management information from delivered key information table T1002 and the present date-time from clocking unit 1026 (step S1200), and judges whether the usage period in the content key management information has lapsed (step S1205).

5        If judged in step S1205 that the usage period has lapsed, time management unit 1023 deletes the acquired content key management information from delivered key information table T1002 (step S1210), adds "1" to the remaining number in content key information corresponding to the delivered  
10 content key ID in the acquired content key management information to update key information table T1001 (step 1215).

Moreover, time management unit 1023 repeats this processing for each piece of content key management  
15 information stored in delivery key management information table T1002.

#### *(4) Operations at Playback Time in Playback Apparatus 1004*

Operations when encrypted contents stored in playback  
20 apparatus 1004 are used will now be described using the Fig. 30 flowchart.

Playback apparatus 1004, on receipt of playback information (step S1250), generates third request information that includes a usage classification showing

"playback apparatus", and transmits the generated third request information to content server 1001 (step 1255).

Content server 1001, on receipt of the third request information (step 1260), conducts mutual authentication with  
5 playback apparatus 1004 (steps S1265, S1270).

Content server 1001 judges whether authentication with playback apparatus 1004 was successful (step S1275).

Content server 1001, if judged at step S1275 that authentication was successful, judges whether the remaining  
10 number in content key information corresponding to the information ID included in the third request information is "0" (step S1285). If judged at step S1275 that authentication was not successful, content server 1001 notifies authentication-failed information to the user (step S1340).

15 Content server 1001, if judged at step S1285 that the remaining number is not "0", generates first key information, encrypts the generated first key information, and transmits the encrypted first key information to playback apparatus 1004 (step S1290). If judged at step S1285 that the remaining  
20 information is "0", content server 1001 notifies none-remaining information to the user (step S1345).

Content server 1001 subtracts "1" from the remaining number in the content key information corresponding to the information ID included in the third request information to



update key information table T1001 (step S1295).

Playback apparatus 1004 judges whether authentication was successful (step S1280).

Playback apparatus 1004, if judged at step S1280 that  
5 authentication was not successful, notifies authentication-failed information to the user (step S1335). If judged that authentication was successful, playback apparatus 1004 receives encrypted first key information from content server 1001, and decrypts the encrypted first key  
10 information to generate first key information (step S1300).

Playback apparatus 1004 stores the generated first key information in usage-key storage unit 1302 (step S1305), and plays a content using the stored first key information and an encrypted content stored in content storage unit 1301  
15 (step S1310). Also, on detecting the end of content usage (step S1315), playback apparatus 1004 deletes the first key information stored in usage-key storage unit 1302 (step S1320), generates key-usage ended information, and transmits the generated key-usage ended information to content server  
20 1001 (step S1325).

On receipt of the key-usage ended information from playback apparatus 1004, content server 1001, using the information ID included in the received key-usage ended information, adds "1" to the remaining number in content key

information corresponding to the information ID, to update key information table T1001 (step S1330).

*(5) Operations at Playback Time in Playback Apparatus 1003*

5        Operations when encrypted contents stored in recording medium 1002 are used in playback apparatus 1003 will now be described using the Fig.31 flowchart.

Playback apparatus 1003, on receipt of playback information (step S1400), judges whether second key  
10 information corresponding to the information ID included in the received playback information exists on recording medium 1002 (step S1405).

If judges at step S1405 that corresponding second key information does exist, playback apparatus 1003 conducts key  
15 confirmation processing (step S1410).

If judges at step S1405 that corresponding second key information does not exist, playback apparatus 1003 generates third request information that includes a usage classification showing "recording medium", and transmits the  
20 generated third request information to content server 1001 (step S1415).

Content server 1001, on receipt of the third request information (step S1420), conducts mutual authentication with recording medium 1002 (steps S1425, S1430).

Content server 1001 judges whether authentication with recording medium 1002 was successful (step S1435).

Content server 1001, if judged at step S1435 that authentication was successful, judges whether the remaining  
5 number in content key information corresponding to the information ID included in the third request information is "0" (step S1445). If judged at step S1435 that authentication was not successful, content server 1001 notifies authentication-failed information to the user (step S1485).

10 Content server 1001, if judged at step S1445 that the remaining number is not "0", generates second key information, encrypts the generated second key information, and transmits the encrypted second key information to playback apparatus 1003 (step S1450). If judged at step S1445 that the remaining  
15 information is "0", content server 1001 notifies none-remaining information to the user (step S1490).

Content server 1001 subtracts "1" from the remaining number in the content key information corresponding to the information ID included in the third request information to  
20 update key information table T1001 (step S1455). Also, content server 1001 generates content key management information, and writes the generated content key management information into delivered key information table T1002 (step S1460).

Recording medium 1002 judges whether authentication was successful (step S1440).

Recording medium 1002, if judged at step S1440 that authentication was not successful, notifies  
5 authentication-failed information to the user (step S1480).  
If judged that authentication was successful, recording medium 1002 outputs authentication-succeeded information to playback apparatus 1003, and playback apparatus 1003 receives encrypted second key information from content  
10 server 1001, and outputs the encrypted second key information to recording medium 1002 (step S1465).

Recording medium 1002 receives the encrypted second key information from playback apparatus 1003, decrypts the encrypted second key information to generate second key  
15 information, and stores the generated second key information in usage-key storage unit 1102 (step S1470).

Playback apparatus 1003 plays a content using an encrypted content and the second key information stored on recording medium 1002 (step S1475).

20

#### *(6) Operations at Time of Recording Medium 1002 Usage in Content Server 1001*

The operations in the case of encrypted content stored on recording medium 1002 being used in content server 1001

will now be described using the Fig.32 flowchart.

Content server 1001, on receipt of playback information whose storage target information is "0" (step S1500), judges whether second key information corresponding to the  
5 information ID included in the received playback information exists on recording medium 1002 (step S1505).

If judges at step S1505 that corresponding second key information does exist, content server 1001 conducts key confirmation processing (step S1510).

10 If judges at step S1505 that corresponding second key information does not exist, content server 1001 conducts mutual authentication with recording medium 1002 (steps S1515, S1520).

Content server 1001 judges whether authentication with  
15 recording medium 1002 was successful (step S1525).

Content server 1001, if judged at step S1525 that authentication was successful, judges whether the remaining number in content key information corresponding to the information ID included in the second request information  
20 is "0" (step S1535). If judged at step S1525 that authentication was not successful, content server 1001 notifies authentication-failed information to the user (step S1565).

Content server 1001, if judged at step S1535 that the

remaining number is not "0", generates second key information, encrypts the generated second key information, and outputs the encrypted second key information to recording medium 1002 (step S1540). If judged at step S1535 that the remaining  
5 information is "0", content server 1001 notifies none-remaining information to the user (step S1570).

Content server 1001 subtracts "1" from the remaining number in the content key information corresponding to the information ID included in the second request information  
10 to update key information table T1001 (step S1545). Also, content server 1001 generates content key management information, and writes the generated content key management information into delivered key information table T1002 (step S1550). Furthermore, content server 1001 reads, from  
15 recording medium 1002, the second key information outputted to recording medium 1002 and an encrypted content, and plays a content (step S1555).

Recording medium 1002 judges whether authentication was successful (step S1520).

20 Recording medium 1002, if judged at step S1520 that authentication was not successful, notifies authentication-failed information to the user (step S1575). If judged that authentication was successful, recording medium 1002 receives encrypted second key information from

content server 1001, decrypts the encrypted second key information to generate second key information, and stores the generated second key information in usage-key storage unit 1102 (step S1560).

5

#### *(7) Playback Operations of Content Server 1001*

Operation when encrypted contents stored in content server 1001 are played will now be described using the Fig.33 flowchart.

10       Content server 1001, on receipt of playback information whose storage target information is "1" (step S1600), judges whether the remaining number in content key information corresponding to the information ID included in first request information generated using the received playback  
15 information is "0" (step S1605).

Content server 1001, if judged at step S1605 that the remaining number is not "0", generates first key information, and stores the generated first key information in usage-key storage unit 1013 (step S1610). Content server 1001, if  
20 judged that the remaining number is "0", notifies none-remaining information to the user (step S1640).

Content server 1001 subtracts "1" from the remaining number in the content key information corresponding to the information ID included in the first request information to

update key information table 1001 (step 1615). Furthermore, content server 1001 uses a content, using the first key information and an encrypted content (step S1620). Also, on detecting the end of content usage (step S1625), content  
5 server 1001 deletes the first key information stored in usage-key storage unit 1013 (step S1630), and adds "1" to the remaining number in the content key information corresponding to the information ID of the encrypted content that was used, to update key information table 1001 (step  
10 1635).

#### (8) Key Confirmation Processing Operations

The key confirmation processing operation shown in Fig.31 will now be described in detail using the Fig.34  
15 flowchart. Key confirmation processing is processing conducted in playback unit 1202 and usage-key confirmation unit 1203 of playback apparatus 1003.

Usage-key confirmation unit 1203 judges whether the usage period of the content key included in existing second  
20 key information has lapsed (step S1660). If judged to be within the usage period, playback unit 1202 acquires the content key, decrypts an encrypted content using the acquired content key to generate a content, and plays the generated content (step S1670).



If judged to be outside the usage period, usage-key confirmation unit 1203 deletes the second key information that includes the content key (step S1675), and notifies usage-failure information to the user (step S1680).

5           Moreover, since the key delivery processing operation shown in Fig.32 is the same, a description is omitted here. The key delivery processing is conducted in playback unit 1017 and usage-key confirmation unit 1019 of content server 1001.

10

*(9) Operations at Time of Advance Delivery of Content Keys*

Operations in the case of delivery content keys in advance to recording medium 1002 will now be described using the Fig.35 flowchart.

15           Content server 1001, on receipt of advance request information, outputs information to recording medium 1002 indicating that advance request information has been received (step S1700).

20           Recording medium 1002 receives the information indicating that advance request information has been received (step S1705), and conducts mutual authentication with content server 1001 (steps S1710, S1715).

Content server 1001 judges whether authentication with recording medium 1002 was successful (step S1720).

Content server 1001, if judged at step S1720 that authentication was successful, judges whether the remaining number in content key information corresponding to the information ID included in the advance request information is "0" (step S1730). If judged at step S1720 that authentication was not successful, content server 1001 notifies authentication-failed information to the user (step S1755).

Content server 1001, if judged at step S1535 that the remaining number is not "0", generates second key information, encrypts the generated second key information, and outputs the encrypted second key information to recording medium 1002 (step S1735). If judged at step S1730 that the remaining information is "0", content server 1001 notifies none-remaining information to the user (step S1760).

Content server 1001 subtracts "1" from the remaining number in the content key information corresponding to the information ID included in the advance request information to update key information table T1001 (step S1740). Also, content server 1001 generates content key management information, and writes the generated content key management information into delivered key information table T1002 (step S1745).

Recording medium 1002 judges whether authentication

was successful (step S1725).

Recording medium 1002, if judged at step S1725 that authentication was not successful, notifies authentication-failed information to the user (step S1765).

5 If judged that authentication was successful, recording medium 1002 receives encrypted second key information from content server 1001, decrypts the encrypted second key information to generate second key information, and stores the generated second key information in usage-key storage  
10 unit 1102 (step S1750).

### *3.7 Summary of Key Delivery Method Variation*

As described above, content server 1001 in key delivery system 1000, when the legitimacy of key delivery is confirmed  
15 by authentication and the remaining number of a content key whose delivery has been request is not "0", delivers the content key. Also, in the delivery of content keys to recording medium 1002, content server 1001 restricts the use of content keys delivered to recording medium 1002, by  
20 appending a usage period for which the content key can be used. In this way, it is always possible to restrict content usage with respect to recording medium 1002, which is not network-connected.

### 3.8 Further Variations

The key delivery method variation described above is one exemplary implementation of the present invention, and the present is not limited to this embodiment, it being possible to implement various structures within a range that does not diverge from the object of this embodiment. Variations such as the following are also included in the present invention.

(1) Although the above is described in terms of all of the content information being encrypted when contents are encrypted in content server 1001, the present invention is not limited to this, and only part of a content need be encrypted.

(2) Only playback apparatus 1004, recording medium 1002 and content server 1001 structuring delivery system may be allowed to duplicate encrypted contents.

In this case, the duplication source and duplication target may conduct authentication at the time of duplication, and duplication only conducted if authentication is successful.

(3) Also, with respect to a playback apparatus or a recording medium that fails the authentication (i.e. does not have common secret information), an allowable number of duplications may be set, and duplication permitted only by

a content server. In this case, the allowable number of duplications is reduced by "1" every time duplication is conducted.

(4) The recording medium may be a portable recording  
5 medium that has an internal IC, an authentication function, and is used by being mounted in a playback apparatus, an example of which is an SD card.

Also, in the case of a portable recording medium that does not have an internal IC, authentication need only be  
10 conducted by content server 1001, instead of conducting mutual authentication.

In this case, common secret information is recorded in the portable recording medium that does not have an internal IC, and content server 1001 conducts authentication by  
15 judging whether the common secret information exists.

The portable recording medium not having an internal IC is, for example, a BD (blu-ray disc) or a DVD.

Also, the recording medium is not limited to being a portable recording medium, and may be a portable terminal  
20 apparatus. In this case, the portable terminal apparatus, when connected to GW 1007, transmits third request information whose usage classification is "recording medium" to content server 1001, and if authentication is successful and there is a remaining deliverable number of a content key,

portable terminal apparatus is able to receive encrypted second key information from content server 1001. The portable terminal apparatus is, for example, a PDA (personal digital assistant) or a notebook personal computer.

5       (5) Although usage-key confirmation unit 1203 was described above as being provided in playback apparatus 1003, the present invention is not limited to this. Usage-key confirmation unit 1203 may be included in recording medium 1002 and its functions realized using clocking unit 1206 and  
10   communication unit 1205 of playback apparatus 1003.

Also, usage-key confirmation unit 1019 provided in content server 1001 may be included in recording medium 1002.

Also, usage-key advance delivery unit 1020 may be included in recording medium 1002.

15       (6) Although the total number of a content key distributed by content server 1001 is described above as being the same for each content key, the present invention is not limited to this. The total number may be different for every content key. In this case, the total number is  
20   received by input unit 1016, content key information is generated in content acquisition unit 1015 using the received total number, and the generated content key information is stored in key-information storage unit 1031.

Also, the time period restriction may be different for

every content key, the same as with the time period restriction in content key information. In this case, the time period restriction is received by input unit 1016, content key information is generated in content acquisition  
5 unit 1015 using the received time period restriction, and the generated content key information is stored in key-information storage unit 1031.

(7) The total number of a content key distributed by content server 1001 may be divided for managing between the  
10 number delivered to playback apparatuses and the number delivered to recording media.

(8) Playback apparatuses 1003 and 1004 may be the same playback apparatus.

(9) Although the above was described in terms of advance  
15 key delivery being possible when recording medium 1002 is mounted in content server 1001, the present invention may be structured so that advance delivery of keys from content server 1001 is conductible when recording medium 1002 is mounted in playback apparatus 1003.

20 (10) Although the above was described in terms of key information table T1001 and delivered key information table T1002 being separate, they may be the same information table.

In this case, the information table includes an area for storing one or more groupings that are each formed from

a content key ID, a content key, a corresponding information ID, a total number, a remaining number, a time period restriction, and period information. The period information is structured from usage period 1, usage period 2, ..., usage period  $n$ . Here, " $n$ " is a number greater than or equal to the number recorded in the total number. Usage period 1 is the same information as the usage period shown in the above key delivery method variation. Also, since usage period 2, ..., usage period  $n$  are the same as usage period 1, a description is omitted here.

(11) A usage-key monitoring unit may be included in playback apparatus 1003, the same as playback apparatus 1004.

In this case, the usage-key monitoring unit in playback apparatus 1003, when detecting the end of usage of encrypted content stored on recording medium 1002, deletes the second key information using in the encrypted content usage, and transmits, to content server 1001, information formed from key-usage ended information, the used content key ID, and the usage period corresponding to the content ID.

Content server 1001, on receipt of the above information from playback apparatus 1003, adds "1" to the remaining number in content key information corresponding to the information ID included in the key-usage ended information to update key information table T1001. Also,



content server 1001 deletes the grouping of the used content key ID and the usage period that corresponds to the content ID from delivered key information table T1002.

(12) Although the above was described in terms of  
5 managing the usage period of content keys included in delivered second key information in content server 1001 in the case of second key information being delivered to recording medium 1002, the usage period of content keys delivered to playback apparatus 1004 may also be managed.

10 In this case, content server 1001 transmits second key information to playback apparatus 1004, and stores, in delivered key information table T1002, a grouping formed from the content key ID and the usage period delivered to playback apparatus 1004. Management of the usage period after  
15 transmission of the second key information is conducted in time management unit 1023.

Playback apparatus 1004, the same as when encrypted contents stored on recording medium 1002 are used, judges after receiving playback information whether there exists  
20 a content key corresponding to the information ID included in the received playback information, and if judged that a corresponding content key does exist, playback apparatus 1004 judges whether the usage period has lapsed. If judged that the usage period has lapsed, playback apparatus 1004

deletes content key management information that includes the content key, and notifies usage-failure information to the user. If judged to be within the usage period, playback apparatus 1004 generates a content using the content key,  
5 and plays the generated content.

If judged that a corresponding content key does not exist, playback apparatus 1004 generates third request information that includes a usage classification showing "playback apparatus" and the information ID included in the  
10 received playback information, and transmits the generated third request information to content server 1001. Since the subsequent operations are the same as the above key delivery method variation, a description is omitted here.

Also, even when playback apparatus 1004 outputs a  
15 content key to usage-key storage unit 1013 of content server 1001, it is possible to manage the usage period of the outputted content key by the same method as above.

Moreover, second key information for delivery is encrypted the same as in the above key delivery method  
20 variation.

(13) Also, playback apparatus 1004 may manage delivered second key information by the same method as content server 1001.

In this case, clocking unit 1310 and a time management

unit 1311 are provided in playback apparatus 1004. Clocking unit 1310 clocks date-time. Time management unit 1311 judges whether the usage period of second key information stored in usage key storage unit 1302 has lapsed, using the date-time  
5 clocked in clocking unit 1310. If judged that the usage period has lapsed, playback apparatus 1004 deletes the second key information, and transmits key-usage ended information to content server 1001.

Also, the same management as above is also possible in  
10 content server 1001 using clocking unit 1026, time management unit 1023, and usage-key information unit 1013.

Also, time management unit 1110 may be provided in recording medium 1002 to conduct the same management as above. In this case, the operations shown above are only conducted  
15 while power is supplied to recording medium 1002 mounted in playback apparatus 1003.

(14) Also, a distinction may be made between a playback apparatus that conducts time management, and a playback apparatus that does not conduct time management. Moreover,  
20 a recording medium may also be included in the playback apparatus that conducts time management.

In this case, a playback apparatus that conducts time management, transmits to content server 1001 third request information that has appended information showing that the

playback apparatus conducts time management, instead of a usage classification, and a playback apparatus that does not conduct time management, transmits to content server 1001 third request information that has appended information  
5 showing that the playback apparatus does not conduct time management, instead of a usage classification. Content server 1001 judges whether the delivery target apparatus is a playback apparatus that conducts time management, and if judged to be a playback apparatus that conducts time  
10 management, content server 1001 transmits encrypted second key information, and if judged to be a playback apparatus that does not conduct time management, content server 1001 transmits encrypted first key information.

(15) Also, second key information delivered to playback  
15 apparatus 1004 need only be managed by content server 1001. Moreover, the second key information is encrypted before being delivered.

In this case, playback apparatus 1004 has an apparatus ID. Here, an apparatus ID is an identifier that identifies  
20 a playback apparatus. A different apparatus ID is allotted to each playback apparatus.

Content server 1001 stores a delivered content key, a usage period, and the apparatus ID of playback apparatus 1004 to which the content key was delivered.

Content server 1001, after transmitting second key information to playback apparatus 1004, judges in time management unit 1023 whether the usage period of the content key delivered to playback apparatus 1004 has lapsed, and if  
5 judged to have lapsed, key deletion information that includes the content key ID whose usage period has lapsed is transmitted from content server 1001 to playback apparatus 1004, and "1" is added to the remaining number included in corresponding content key information in the key information  
10 table. At this time, playback apparatus 1004, having received the key deletion information, deletes second key information corresponding to the content key ID included in the received information.

Also, even when content server 1001 outputs content  
15 keys to usage-key storage unit 1013 in content server 1001, it is possible to conduct management by the same method as above.

Also, when there is a plurality of playback apparatuses having the same structure as playback apparatus 1004, key  
20 deletion information may be transmitted collectively to one or more of the playback apparatuses. In this case, the number added to the remaining number included in corresponding content key information within key information table T1001 is same as the number of playback apparatuses to which the

key deletion information is transmitted.

(16) The function of delivering first key information to playback apparatus 1004 at a specified time may be included in content server 1001. Moreover, the delivered first key  
5 information is encrypted the same as in the above key delivery method variation.

In this case, content server 1001 further includes an automatic delivery information storage unit 1041 that stores automatic delivery information formed from a delivery  
10 date-time showing a date-time for delivering a content key, first key information for delivery, and an apparatus ID of the playback apparatus that will conduct the delivery, an automatic delivery management unit 1042 that manages whether the date-time to deliver the first key information has been  
15 reached, and a specified time delivery unit 1043 that delivers the first key information when the delivery date-time is reached.

Content server 1001, on receipt of date-time information for conducting automatic delivery, and automatic  
20 request information that includes an apparatus ID, conducts authentication. Content server 1001, if authentication is successful, generates automatic delivery information, stores the generated automatic delivery information in automatic delivery information storage unit 1041, and

subtracts "1" from the remaining number included in corresponding content key information within key information table T1001. Automatic delivery management unit 1042 judges whether the present date-time has reached the delivery  
5 date-time included in the automatic delivery information stored in automatic delivery information storage unit 1041, and if judged to have reached the deliver date-time, specified time delivery unit 1043 delivers first key information to playback apparatus 1004, which corresponds  
10 to the apparatus ID included in the automatic delivery information, and deletes the automatic delivery information stored in automatic delivery information storage unit 1041.

Moreover, in the case of there being a plurality of playback apparatuses having the same structure as playback  
15 apparatus 1004, content keys may be delivered collectively to each playback apparatus specifying the same date-time, in the case of the same date-time information being received from one or more of the playback apparatuses.

Also, information stored in automatic delivery  
20 information storage unit 1041 may be set as a delivery date-time, an apparatus ID, and second key information, and the second key information may be delivered to playback apparatus 1004 instead of the above-mentioned first key information.

Also, second key information may also be delivered at a specified time with respect to recording medium 1002. In this case, the apparatus ID stored in automatic delivery information storage unit 1041 is the apparatus ID of playback  
5 apparatus 1003 in which recording medium 1002 is mounted.

Also, by input unit 1016 in content server 1001 receiving automatic request information, automatic delivery to usage-key storage unit 1013 in content server 1001 is also possible the same in as the above operations. Authentication,  
10 however, is not conducted.

Also, by input unit 1016 in content server 1001 receiving automatic request information to which is appended information showing the delivery target of a content key to be recording medium 1002 or usage-key storage unit 1013 in  
15 content server 1001, it is possible to switch between automatic delivery to recording medium 1002 and automatic delivery to usage-key storage unit 1013 in content server 1001. In this case, the information to be delivered is second key information.

20 Also, information stored in automatic delivery information storage unit 1041 may be set as a delivery date-time and an apparatus ID, and first or second key information may be generated at an automatic delivery time.

Also, first key information for automatic delivery may



be encrypted by common key encryption and transmitted.

Also, authentication may be conducted again at an automatic delivery time. First or second key information to be delivered may be encrypted using the encryption key  
5 generated at a time of this authentication.

(17) The function of detecting the delivery target of delivered content keys may be added in key delivery system 1000.

In this case, playback apparatus 1004 includes a key  
10 detection unit 1320 for detecting the existence of content keys specified by content server 1001, and recording medium 1002 also includes a key detecting unit 1120 the same as playback apparatus 1004.

Content server 1001 transmits, to playback apparatus  
15 1003 and playback apparatus 1004, key detection request information that includes a content key ID corresponding to a content key to be detected.

Playback apparatus 1004, on receipt of key detection request information from content server 1001, judges in key  
20 detection unit 1320 whether the content key ID included in the received key detection request information exists in usage-key storage unit 1302, and if judged to exist, transmits information to content server 1001 indicating that the content key to which the detection request relates is

being held.

Playback apparatus 1003, on receipt of key detection request information from content server 1001, outputs the received key detection request information to recording  
5 medium 1002. Recording medium 1002, on receipt of the key detection request information, judges in key detection unit 1120 whether the content key ID included in the received key detection request information exists in usage-key storage unit 1102, and if judged to exist, transmits information to  
10 content server 1001 indicating that the content key to which the detection request relates is being held.

Also, although the above was described in terms of detection being conducted using a content key ID, a corresponding-information ID may be used instead of a content  
15 key ID. In this case also, detection by the same method as above is possible.

Also, a key detection unit may be included in playback apparatus 1003, instead of including key detection unit 1120 in recording medium 1002.

20 In this way, it is possible to manage playback apparatuses and recording media holding content keys to be detected, without needing to use a database or the like to manage playback apparatuses and recording media to which content keys have been delivered.

(18) Although the above was described in terms of contents being information delivered from a broadcast station, the present invention is not limited to this.

For example, contents may be information obtained by digitalizing music information, video, computer programs, and the like.

(19) In the above key delivery method variation, an encrypted content corresponding to first key information may be transmitted at a time of transmitting first key information from content server 1001 to playback apparatus 1004. Also, in the same way, an encrypted content corresponding to second key information may be transmitted at a time of transmitting second key information from content server 1001 to recording medium 1002.

(20) Second key information stored in recording medium 1002 may be encrypted second key information.

For example, after generating second key information in content server 1001, the second key information is encrypted using common secret information as an encryption key, and the encrypted second key information delivered to recording medium 1002. Recording medium 1002 stores the encrypted second key information, decrypts the encrypted second key information at a usage time using the common secret information, to generate second key information, and uses

the generated second key information.

Moreover, at a time of delivering encrypted second key information, the encrypted second key information may be further encrypted using the shared secret key used at the  
5 time of authentication, and delivered.

(21) Although the above was described in terms of content server 1001, when a content key is to be outputted to recording medium 1002 mounted in content server 1001, encrypting and outputting the second key information, the  
10 second key information may be outputted without being encrypted.

Also, when first key information is delivered to playback apparatus 1004 via a network, the first key information may be outputted without being encrypted, the  
15 same as when second key information is delivered to recording medium 1002.

(22) The usage frequency of delivered content keys may be managed.

In this case, information showing content key usage is  
20 transmitted to a content server every time a content key is used. The content server, on receipt of the information showing content key usage, judges whether the usage frequency of the content key distributed to a recording medium has reached a predetermined frequency, and if judged to have

reached to predetermined frequency, the content server adds "1" to the remaining number corresponding to the content key, and notifies information to the recording medium indicating that the usage frequency has reached the predetermined  
5 frequency. The recording medium, on receipt of this information, deletes the content key after use.

(23) Also, a content server may manage history information showing a usage condition of a content key delivered to a recording medium, and if usage of the content  
10 key is less than a certain predetermined time period, the content server may add "1" to the remaining number corresponding to the content key, and append usage-failure information to the history information of the content key.

In this case, the recording medium transmits  
15 information to the content server showing content key usage, every time a delivered content key is used. The content server, on receipt of the information showing content key usage, judges whether usage of the content key by the recording medium is possible, and if usage is possible, the content  
20 server stores the information. If usage is not possible, the content server notifies information to the recording medium showing that usage is not possible. The recording medium, having received the notification, deletes the content key.

Also, the content server judges whether a predetermined

time period has lapsed since the last usage of the content key, using the stored information, and if judged to have lapsed, the content server adds "1" to the remaining number corresponding to the content key.

5           (24) It is not absolutely necessary for usage-key storage unit 1013, usage-key monitoring unit 1018, usage-key confirmation unit 1019, usage-key advance delivery unit 1020, content-key control unit 1021, authentication unit 1022, and time management unit 1023 shown in the above key delivery  
10 method variation to be included in content server 1001. For example, a key management server, being a different network terminal to content server 1001 may be added to the structure of the key delivery system, and usage-key storage unit 1013, usage-key monitoring unit 1018, usage-key confirmation unit  
15 1019, usage-key advance delivery unit 1020, content-key control unit 1021, authentication unit 1022, and time management unit 1023 provided in the key management server.

          (25) Although content acquisition unit 1015 shown in the above key delivery method variation prestores a  
20 decryption key for decrypting an encrypted content acquired from broadcast station 1006, the present invention is not limited to this. The decryption key may be delivered from broadcast station 1006 together with the encrypted content.

          In this case, content acquisition unit 1015 receives

the encrypted content and the decryption key from broadcast station 1006 via reception unit 1014.

(26) Although content acquisition unit 1015 shown in the above key delivery method variation decrypts an encrypted content acquired from broadcast station 1006, and encrypts the content again using a content key, the present invention is not limited to this. The encrypted content and the decryption key may be encrypted using the content key to generate encrypted content information, and the encrypted content information stored.

In the case of a content being duplicated to playback apparatus 1004 or recording medium 1002, an information ID and the encrypted content information are duplicated. When the content is used in playback apparatus 1004, the content key is received from content server 1001, the encrypted content information is decrypted using the received content key to generate the encrypted content and the decryption key, and the encrypted content is then decrypted using the decrypted key. Also, when the content recorded on recording medium 1002 is used in playback apparatus 1003, decryption of the encrypted content is conducted by the same operations.

(27) The present invention may be any combination of the key delivery method variation and the further variations.

#### 4. AD Server Variation

In relation to content duplication, AD server 100 may manage management information for permitting duplication with respect to in-group apparatuses and management  
5 information for permitting duplication with respect to out-group apparatuses.

The following description relates to AD server 100 holding management information with respect to both in-group and out-group apparatuses.

10 Since group registration and withdrawal procedures between a playback apparatus and a home server are conducted by the procedures described above, a description is omitted here.

Below, the group formation/management system and the  
15 AD server are referred to respectively as a content-duplication management system and a home server.

##### 4.1 Overview

Fig.36 is a block diagram showing a structure of a  
20 content-duplication management system 2000.

A home server 2001, a playback apparatus 2002, and a playback apparatus 2003 are connected via a gateway (GW) 2005 and form a home network.

A recording medium 2004 is connected to playback



apparatus 2003 by being inserted into an insertion opening in playback apparatus 2003.

Home server 2001, playback apparatus 2002, and playback apparatus 2003 communicate in the home network using their  
5 respective TCP/IP.

GW 2005 conducts routing processing between the home network and an external network.

A playback apparatus 2006 and a broadcast station 2007 are connected to the external network.

10 Broadcast station 2007 conducts ground-wave digital broadcasting, and broadcasts programs to households using UHF waves.

Home server 2001 has a ground-wave digital broadcast reception function, and receives the broadcast content of  
15 broadcast station 2007, performs operations to change the broadcast content to a predetermined digital data format, and stores the digital data on a mass-storage hard disk as contents.

Home server 2001 manages content duplication with  
20 respect to playback apparatus 2002, playback apparatus 2003, and playback apparatus 2006.

Playback apparatus 2002, playback apparatus 2003 and playback apparatus 2006 acquire contents from home server 2001 when duplication permission relating to the contents

is received from home server 2001, and store and play the acquired contents.

In the present variation, the range of the home network is designated as group 2010.

5        Restrictions applying to content duplication are relaxed in-group (i.e. within group 2010).

Home server 2001, playback apparatus 2002, playback apparatus 2003, GW 2005 and recording medium 2004 belong to group 2010.

10       Apparatuses belonging to the external network cannot be managed by a home network manager or a group 2010 manager.

When contents are to be duplicated to apparatuses belonging to the external network, home server 2001 needs to apply stiffer restrictions than for duplication to  
15    apparatuses within group 2010.

Home server 2001 implements restrictions by the number of duplications permitted of a content.

Home server 2001 distinguishes between in-group and out-group (i.e. outside the range of the home network) in  
20    setting and managing the maximum number of permitted duplications.

Apparatuses and recording media belonging to group 2010 each hold group affiliation information, which is common information showing that the respective apparatus/medium

belongs to group 2010.

Group affiliation information is formed from common secret information distributed to each apparatus/medium secretly, and a device list of devices structuring the group, the device list being issued by a third party known as a certification authority (CA).

## 4.2 Structure

### 4.2.1 Home Server 2001

Home server 2001 is specifically a DVD player or the like that has a network communication function and a hard disk having a mass-storage storage area.

Fig.37 is a block diagram showing a structure of home server 2001.

A communication unit 2101 conducts TCP/IP communication with other apparatuses via a network.

A duplication-restriction information (DRI) management unit 2102 conducts controls pertaining to content duplication.

Figs.38A and 38B shows information held by DRI management unit 2102.

Fig.38A shows duplication-restriction information held by DRI management unit 2102. Duplication-restriction information is information corresponded with contents, and

is formed from a content identifier (ID), an in-group apparatus remaining number, an in-group medium remaining number, out-group apparatus remaining number, out-group medium remaining number, and usage period information.

5           Duplication-restriction information is information relating to contents acquired as a result of broadcasts from broadcast station 2007, and is acquired from broadcast station 2007 via a network, as compared with broadcasts transmitted from broadcast station 2007.

10           A content ID is allotted to each content, and uniquely identifies the respective content.

The in-group apparatus remaining number shows the remaining number of duplications of a content identified by a content ID that can be made to an in-group apparatus.

15           When a content is duplicated to an in-group apparatus, DRI management unit 2102 subtracts "1" from the in-group apparatus remaining number.

When an in-group apparatus deletes a duplicated content, DRI management unit 2102 adds "1" to the in-group apparatus  
20 remaining number.

The out-group apparatus remaining number shows the remaining number of duplications of a content identified by a content ID that can be made to an out-group apparatus.

When a content is duplicated to an out-group apparatus,

DRI management unit 2102 subtracts "1" from the in-group apparatus remaining number.

When an out-group apparatus deletes a duplicated content, DRI management unit 2102 adds "1" to the out-group  
5 apparatus remaining number.

The in-group medium remaining number shows the remaining number of duplications of a content identified by a content ID that can be made to an in-group recording medium.

The out-group medium remaining number shows the  
10 remaining number of duplications of a content identified by a content ID that can be made to an out-group recording medium.

For example, in the case of playback apparatus 2002 in group 2010 requesting server 2001 for content duplication, DRI management unit 2102 gives permission with respect to  
15 the request when the in-group apparatus remaining number is "1" or greater, and notifies a rejection with respect to the request when the in-group apparatus remaining number is "0".

When a content is duplicated from home server 2001 to playback apparatus 2002, DRI management unit 2102 subtracts  
20 "1" from the in-group apparatus remaining number.

Also, when playback apparatus 2002 notifies server 2001 of the deletion of a duplicated content, DRI management unit 2102 adds "1" to the in-group apparatus remaining number.

Usage period information is information showing a

period during which usage of a content is possible.

Usage period information shows, for example, a specific date-time such as 30 June 2005.

When usage period information has been determined and  
5 a content duplicated, DRI management unit 2102 notifies the usage period information to a timer included in a time management unit 2105, and instructs time management unit 2105 to output an expiry date-time reached notification at the time shown in the usage period information.

10 When an expiry date-time reached notification is acquired from time management unit 2105, DRI management unit 2102 judges usage of the duplicated content to have ended, and adds "1" to the in-group apparatus remaining number.

Usage period management processing is described in a  
15 later section.

DRI management unit 2102 receives, by broadcast from an apparatus requesting content duplication (hereinafter "request apparatus"), a confirmation request that includes confirmation information identifying a content that the  
20 request apparatus has targeted for duplication.

When this broadcast is received, DRI management unit 2102 confirms, via communication unit 2101, whether duplication-restriction information that includes a content ID matching the confirmation information is being managed

therein, and if judged in the affirmative, DRI management unit 2102 transmits a duplication permission notification showing "duplication permitted" to the transmission source of the broadcast (i.e. the request apparatus).

5       Also, when an ICMP (Internet Control Message Protocol) echo request message is received, DRI management unit 2102 transmits an ICMP echo reply message to the request apparatus.

      DRI management unit 2102 receives a duplication request  
10   from the request apparatus that includes the confirmation information and attribute information showing "medium" or "apparatus", and transmits an authentication start instruction to an authentication unit 2103.

      DRI management unit 2102 generates request management  
15   information based on the duplication request.

      Request management information is formed from a processing classification showing "duplicate" or "delete", confirmation information identifying a content, the IP address of a request apparatus, in/out group information  
20   showing whether a request apparatus is in-group or out-group, attribute information showing whether a request apparatus is an apparatus or a recording medium, reservation information, and a next request pointer showing the location in which the next piece of request management information

is held.

Reservation information shows a time at which to start duplication or deletion of a content.

Reservation information shows, for example, a specific  
5 date-time such as 30 June 2005.

DRI management unit 2102 acquires reservation information from the request apparatus together with a duplication reservation request.

Fig.38B shows a request management queue for managing  
10 request management information.

In Fig.38B is shown an example in which three pieces of request management information are joined together in the request management queue.

When a duplication request is received, DRI management  
15 unit 2102 writes the IP address of the request apparatus and the confirmation and attribute information included in the duplication request into a generated piece of request management information.

DRI management unit 2102 acquires in/out group  
20 information from authentication unit 2103, and writes the acquired in/out group information into the request management information.

Home server 2001 conducts corresponding processing in order, starting with a request shown by the request



management information indicated by a request head pointer.

Once the corresponding processing has ended, DRI management unit 2102 rewrites the request head pointer to indicate the request management information shown by the next  
5 request pointer in the request management information currently processed.

Also, when a new request is acquired from another apparatus, DRI management unit 2102 newly creates request management information responding to the acquired request,  
10 and joins the newly created request management information to the end of the queue.

When the processing classification in the request management information shows "duplicate", DRI management unit 2102 selects a target remaining number for processing  
15 from the in-group and out-group apparatus/medium remaining numbers, based on a combination of the in/out group information and the attribute information included in the request management information.

For example, when the in/out group information shows  
20 "in-group" and the attribute information shows "apparatus", the target remaining number will be the in-group apparatus remaining number, and when the in/out group information shows "in-group" and the attribute information shows "medium", the target remaining number will be the in-group medium remaining

number.

Next, DRI management unit 2102 investigates whether the target remaining number included in duplication-restriction information whose content ID matches the confirmation  
5 information in the request management information is "0".

If not "0", DRI management unit 2102 judges the content identified by the content ID to be duplicable, and if "0", DRI management unit 2102 judges the content to be unduplicable.

10 If judged to be duplicable, DRI management unit 2102 instructs an encryption/decryption unit 2104 to encrypt the content and transmit the encrypted content to the request apparatus.

Encryption/decryption unit 2104 encrypts the content  
15 and transmits the encrypted content to the request apparatus.

When the processing classification in the request management information shows "delete", DRI management unit 2102 selects a target remaining number for processing from the in-group and out-group apparatus/medium remaining  
20 numbers, based on a combination of the in/out group information and attribute information included in the request management information.

DRI management unit 2102 transmits a return processing start notification to the request apparatus.

Also, when a deletion-completed notification is received from the request apparatus, DRI management unit 2102 adds "1" to the target remaining number included in duplicate-restriction information whose content ID matches  
5 the confirmation information in the request management information.

DRI management unit 2102 deletes the request management information from the queue head to update the request management queue.

10 Also, DRI management unit 2102 receives a transfer request for duplication-restriction information from a request apparatus.

DRI management unit 2102 conducts processing to transfer at least part of the managed  
15 duplication-restriction information to another apparatus.

Duplication-restriction information (DRI) transfer processing is described in a later section.

DRI management unit 2102 receives a duplication reservation request from a request apparatus via  
20 communication unit 2101.

A duplication reservation request includes specification information showing a content relating to the duplication reservation request, and reservation information showing a start time of content duplication.

When the duplication reservation request is received, DRI management unit 2102 judges whether a content ID matching the specification information included in the duplication reservation request is being held, and if judged to be held,  
5 unit 2102 holds the reservation information in correspondence with the content ID.

Also, DRI management unit 2102 notifies the reservation information to the timer included in time management unit 2105 and instructs time management unit 2105 to output a  
10 reservation-time reached notification at the time shown in the reservation information.

Reservation management processing is described in a later section.

Authentication unit 2103 receives an authentication  
15 start instruction from DRI management unit 2102, and executes mutual authentication and key sharing with the request apparatus.

Also, authentication unit 2103 holds group affiliation information showing that home server 2001 belongs to group  
20 2010.

Group affiliation information is, the same as above, formed from common secret information distributed to each apparatus/recording medium secretly, and a device list of devices structuring the group, the device list being issued

by a third party known as a CA.

Mutual authentication and key sharing are described in a later section.

When the mutual authentication and key sharing are  
5 successful, authentication unit 2103 and the request apparatus share session keys, which are the same key.

Authentication unit 2103 holds the session key, and also notifies the session key to encryption/decryption unit 2104.

10 Authentication unit 2103 receives group affiliation information from the request apparatus.

Authentication unit 2103 judges whether the received group affiliation information matches the held group affiliation information, and notifies in/out group  
15 information to DRI management unit 2102 showing "in-group" if judged to match and "out-group" if judged to not match.

Encryption/decryption unit 2104 acquires the session key from authentication unit 2103, in the case of the mutual authentication and the key sharing conducted by  
20 authentication unit 2103 being successful.

Encryption/decryption unit 2104 conducts encryption of data to be transmitted to the request apparatus, and decryption of data received from the request apparatus, using the session key, in the case of the mutual authentication

and the key sharing being successful.

Time management unit 2105 includes a clock and a timer.

The clock, for example, counts up in 1-second increments, and is constituted by a counter that shows the  
5 seconds counted from 00:00:00, 1 January 1970.

A timer notification request time is set in the timer by a notification request source.

The timer sends a notification to the notification request source showing that the set time has been reached,  
10 when the clock indicates the time shown by the timer notification request time.

A ground-wave digital broadcast (GDB) reception unit 2106 receives programs from broadcast station 2007.

GDB reception unit 2106 acquires video information,  
15 audio information, data broadcast information, control information, required in content playback, that includes a content ID, and other information, by conducting demodulation, demultiplexing, decryption and the like using a specified method, with respect to received broadcast  
20 signals.

GDB reception unit 2106 converts the video information, audio information, and data broadcast information to a predetermined digital data format (e.g. TS packets), and outputs the digital data to a storage unit 2107 as contents.

Storage unit 2107 stores contents received from GDB reception unit 2106 in correspondence with content IDs.

Storage unit 2107 is tamper-resistant, and information held therein cannot be accessed from sources external to home  
5 server 2101.

#### 4.2.2 *Playback Apparatus 2002*

Playback apparatus 2002 is specifically a DVD player or the like that has a network communication function and  
10 a hard disk having a mass-storage storage area.

Fig.39 is a block diagram showing a structure of playback apparatus 2002.

A communication unit 2201 conducts TCP/IP communication with other apparatuses via a network.

15 A duplication restriction information (DRI) management unit 2202 manages content duplication.

Since the operations of DRI management unit 2202 are substantially the same as DRI management unit 2102, the following description relates to the differences.

20 DRI management unit 2202 transmits, to a content duplication source, a duplication request that includes confirmation information identifying a content targeted for duplication and attribute information showing "medium" or "apparatus".

The attribute information is information showing "apparatus" when the transmission source is an apparatus such as playback apparatus 2002, and "medium" when the transmission source is a recording medium such as recording  
5 medium 2004.

As such, attribute information transmitted by playback apparatus 2002 shows "apparatus".

Duplication restriction information is managed by a server that conducts content distribution.

10 Playback apparatus 2002 possesses rights to distribute contents, as a result of receiving transfer of rights permitting duplication from home server 2001, which possesses rights permitting content duplication.

DRI management unit 2202 acquires, from home server  
15 2001, a content ID, the in-group remaining apparatus number, the out-group apparatus remaining number, the in-group medium remaining number, the out-group medium remaining number, and usage period information, and holds the received information as duplication-restriction information.

20 DRI management unit 2202 is structured the same as DRI management unit 2102.

Here, playback apparatus 2002 is not required to hold a content corresponding to the acquired content ID, and another apparatus may hold the content corresponding to the



content ID.

In this case, DRI management unit 2202, when a duplication request for the content is received from another apparatus and duplication of the content is permitted,  
5 instructs an apparatus holding the content to transmit the content to the apparatus that made the duplication request.

Also, in-group and out-group apparatus/medium remaining numbers acquired from home server 2001 may be only part, rather than all, of the corresponding remaining numbers  
10 held by home server 2001.

For example, home server 2001 may, when holding a value of "10" as the in-group apparatus remaining number, only transfer a value of "5" as the in-group apparatus remaining number.

15 In this case, playback apparatus 2002 possesses rights that permit up to five duplications of the content, with respect to in-group apparatuses.

Also, playback apparatus 2002 may return all or part of the duplication-restriction information acquired from  
20 home server 2001.

For example, playback apparatus 2002 may only return a value of "2" to home server 2001 as the in-group apparatus remaining number.

The transfer and return of duplication-restriction

information are described in a later section.

An authentication unit 2203 executes mutual authentication and key sharing with an apparatus for authenticating (hereinafter "authentication apparatus").

5       Authentication unit 2203 holds group affiliation information showing that playback apparatus 2002 belongs to group 2010.

Mutual authentication and key sharing are described in a later section.

10       When the mutual authentication and the key sharing are successful, authentication unit 2203 and the authentication apparatus share session keys, which are the same key.

Authentication unit 2203 holds the session key, and also notifies the session key to an encryption/decryption  
15   unit 2204.

Encryption/decryption unit 2204 acquires the session key from authentication unit 2203, in the case of the mutual authentication and the key sharing conducted by authentication unit 2203 being successful.

20       Encryption/decryption unit 2204 conducts encryption of data to be transmitted to the authentication apparatus, and decryption of data received from the authentication apparatus, using the session key, in the case of the mutual authentication and the key sharing being successful.

A time management unit 2205 includes a clock and a timer.

The clock, for example, counts up in 1-second increments, and is constituted by a counter that shows the  
5 seconds counted from 00:00:00, 1 January 1970.

A timer notification request time is set in the timer by a notification request source.

The timer sends a notification to the notification request source showing that the set time has been reached,  
10 when the clock indicates the time shown by the timer notification request time.

A content distribution source (CDS) determining unit 2206 determines, from servers and/or apparatuses that have received transfer of content duplication rights, a  
15 distribution-source apparatus from which to receive content duplication permission.

CDS determining unit 2206 broadcasts, over a network, a confirmation request that includes confirmation information showing a content targeted for duplication.

20 CDS determining unit 2206 transmits an ICMP echo request message to apparatuses that respond to the confirmation request in the order in which the replies are received, and measures the round-trip time, which is the time period from transmission of the ICMP echo request message

until reception of an ICMP echo reply message.

CDS determining unit 2206 determines the apparatus with the shortest round-trip time as the distribution source apparatus, and notifies the determined distribution source  
5 apparatus to DRI management unit 2202.

A storage unit 2207 holds contents.

A playback unit 2208 plays contents held by storage unit 2207 or contents received by communication unit 2201.

#### 10 4.2.3 *Playback Apparatus 2003*

Playback apparatus 2003 is specifically an SD player that has a network communication function.

Fig.40 is a block diagram showing a structure of playback apparatus 2003 and internal IC portable recording  
15 medium 2004.

A communication unit 2301 conducts TCP/IP communication with other apparatuses via a network.

An input/output (IO) unit 2303 is connected to and communicates with recording medium 2004.

20 A playback unit 2302 plays contents read from recording medium 2004.

#### 4.2.4 *Recording Medium 2004*

Recording medium 2004 is specifically an SD card that

is tamper-resistant and has an internal IC.

An input/output (IO) unit 2311 communicates with playback apparatus 2003.

Recording medium 2004 communicates with other  
5 apparatuses via playback apparatus 2003.

The description of a content distribution source (CDS) determining unit 2312 is the same as the description of CDS determining unit 2206.

CDS determining unit 2312 transmits a duplication  
10 request that includes confirmation information and attribute information to the apparatus determined as the distribution source apparatus.

An authentication unit 2313 communicates with an apparatus for authenticating (hereinafter "authentication  
15 apparatus") via playback apparatus 2003 and a network, and executes mutual authentication and key sharing with the authentication apparatus.

Authentication unit 2313 holds group affiliation information showing that recording medium 2004 belongs to  
20 group 2010.

Mutual authentication and key sharing are described in a later section.

When the mutual authentication and key sharing are successful, authentication unit 2313 and the authentication

apparatus share session keys, which are the same key.

Authentication unit 2313 holds the session key, and also notifies the session key to an encryption/decryption unit 2314.

5        Encryption/decryption unit 2314 acquires the session key from authentication unit 2313, in the case of the mutual authentication and the key sharing conducted by authentication unit 2313 being successful.

10       Encryption/decryption unit 2314 conducts encryption of data to be transmitted to the authentication apparatus, and decryption of data received from the authentication apparatus, using the session key, in the case of the mutual authentication and the key sharing being successful.

A storage unit 2315 holds contents.

15

#### 4.2.5 Playback Apparatus 2006

Playback apparatus 2006 is specifically a DVD player or the like that has a network communication function and a hard disk having a mass-storage storage area.

20       Fig.41 is a block diagram showing a structure of playback apparatus 2006.

A communication unit 2401 conducts TCP/IP communication with other apparatuses via a network.

An authentication unit 2402 executes mutual

authentication and key sharing with a server holding contents.

Authentication unit 2402, however, does not hold group affiliation information, and so playback apparatus 2006 is  
5 judged in home server 2001 to be an out-group apparatus.

Mutual authentication and key sharing are described in a later section.

When the mutual authentication and the key sharing are successful, authentication unit 2402 and the server share  
10 session keys, which are the same key.

Authentication unit 2402 holds the session key and also notifies the session key to an encryption/decryption unit 2403.

Encryption/decryption unit 2403 acquires the session  
15 key from authentication unit 2402, in the case of the mutual authentication and the key sharing conducted by authentication unit 2402 being successful.

Encryption/decryption unit 2403 conducts encryption of data to be transmitted to the server, and decryption of data  
20 received from the server, using the session key, in the case of the mutual authentication and the key sharing being successful.

A storage unit 2404 holds contents.

### 4.3 Operations

#### 4.3.1 Duplication-Source Determination Processing

A request apparatus determines, from apparatuses connected to a network, a delivery apparatus as the content  
5 duplication source.

Fig.42 is a flowchart showing duplication-source determination processing.

In the given example, the request apparatus, the delivery apparatus, and the other device are playback  
10 apparatus 2002, home server 2001, and playback apparatus 2003, respectively.

The "delivery apparatus" is the apparatus selected from among possible delivery apparatuses as the duplication source, as a result of duplication-source determination  
15 processing.

The "other apparatus" is the apparatus not selected from among possible delivery apparatuses as the duplication source, as a result of the duplication-source determination processing.

20 The "request apparatus" is the apparatus that requests content duplication, and thus if the playback apparatus 2003 makes a content duplication request, playback apparatus 2003 is the request apparatus.

The request apparatus determines which apparatus to



request for duplication of a content targeted for duplication  
(i.e. shown by the confirmation information).

Specifically, the request apparatus broadcast  
transmits a confirmation request over a network, with the  
5 aim of acquiring a response from apparatuses holding the  
targeted content (S2001).

The confirmation request includes confirmation  
information identifying the content targeted by the request  
apparatus for duplication.

10 The delivery apparatus and the other apparatus receive  
the confirmation request.

The delivery apparatus confirms whether a content ID  
matching the confirmation information in the confirmation  
request is being managed therein (S2002).

15 The other apparatus confirms whether a content ID  
matching the confirmation information in the confirmation  
request is being managed therein (S2003).

The delivery apparatus, when managing a matching  
content ID (S2002 = YES), transmits a duplication permission  
20 notification to the request apparatus showing "duplication  
permitted" (S2004).

The delivery apparatus, when not managing a matching  
content ID (S2002 = NO), ends the processing.

The other apparatus, when managing a matching content

ID (S2003 = YES), transmits a duplication permission notification to the request apparatus showing "duplication permitted" (S2005).

5 The other apparatus, when not managing a matching content ID (S2003 = NO), ends the processing.

The request apparatus confirms the content of received duplication permission notifications, and holds a transmission source IP address of apparatuses that transmitted a duplication permission notification showing  
10 "duplication permitted" (S2006).

The request apparatus transmits an ICMP echo request message to apparatuses having the held IP addresses, and measures the round-trip time from the transmission time until receipt of an ICMP echo reply message.

15 The request apparatus transmits an ICMP echo request message to the delivery apparatus (S2007).

The delivery apparatus receives the ICMP echo request message and in response transmits an ICMP echo reply message to the request apparatus (S2008).

20 The request apparatus receives the ICMP echo reply message from the delivery apparatus and holds the measured round-trip time.

The request apparatus transmits an ICMP echo request message to the other apparatus (S2009).

The other apparatus receives the ICMP echo request message and in response transmits an ICMP echo reply message to the request apparatus (S2010).

The request apparatus receives the ICMP echo reply  
5 message from the other apparatus, and holds the measured round-trip time.

The request apparatus selects the apparatus having the shortest round-trip time as the duplication-source apparatus, and holds the IP address of the selected apparatus (S2011).

10

#### 4.3.2 *Mutual Authentication and Key Sharing*

Figs.43 and 44 are flowcharts showing mutual device authentication and key sharing operations conducted between a delivery apparatus and a request apparatus.

15 In the given example, playback apparatus 2002 selects home server 2001 as the duplication source, as a result of the duplication-source determination processing shown in Fig.42.

20 As such, the following description relates to an example in which the delivery apparatus is home server 2001 and the request apparatus is playback apparatus 2002.

Authentication unit 2103 in host server 2001 prestores a public key *PK-CA* of a certification authority (CA), a secret key *SK-A* and a public key certificate *Cert-A*, and has an

encryption unit as a result of an elliptic curve  $E$ .

Also, authentication unit 2203 in playback apparatus 2002 prestores a public key  $PK-CA$  of the CA, a secret key  $SK-i$  and a public key certificate  $Cert-i$ , and has an  
5 encryption unit as a result of elliptic curve  $E$ .

Also,  $Sig(SK, D)$  is an operation in which a digital signature is performed on data  $D$  using a secret key  $SK$ .

Also, " $G$ " is a base point on elliptic curve  $E$ , and is a value unique to the present authentication system.

10 Also, " $*$ " is an operand showing multiplication over elliptic curve  $E$ .

For example, " $x * G$ " is an operation in which point  $G$  on elliptic curve  $E$  is added together  $x$  times.

" $\parallel$ " is an operand showing a concatenation operation,  
15 and " $A \parallel B$ " for example results from " $A$ " and " $B$ " being concatenated.

Below, "authentication unit 2103 outputs information to authentication unit 2203", "authentication unit 2203 outputs information to authentication unit 2103" and so forth  
20 are abbreviated sentences whose expanded meanings are respectively, "authentication unit 2103 outputs information to authentication unit 2203 via communication unit 2101 and communication unit 2201", "authentication unit 2203 outputs information to authentication unit 2103 via communication

unit 2201 and communication unit 2101".

Authentication unit 2203 generates a random number  $y$  (S2101), and outputs the generated random number  $y$  and public key certificate  $Cert-i$  to authentication unit 2103 (S2102).

5        Authentication unit 2103 receives random number  $y$  and public key certificate  $Cert-i$  (S2102), and confirms that public key certificate  $Cert-i$  of playback apparatus 2002 is not revoked, using a CRL (S2103).

      If revoked (S2104 = NO), authentication unit 2103 ends  
10    the processing.

      If not revoked (S2104 = YES), authentication unit 2103 verifies public key certificate  $Cert-i$  using public key  $PK-CA$  (S2105).

      If verification fails (S2106 = NO), authentication unit  
15    2103 ends the processing.

      If verification succeeds (S2106 = YES), authentication unit 2103 generates a random number  $x$  (S2107), and outputs the generated random number  $x$  and public key certificate  $Cert-A$  to authentication unit 2203 (S2108).

20        Authentication unit 2203 receives random number  $x$  and public key certificate  $Cert-A$  from authentication unit 2103 (S2108).

      Next, authentication unit 2203 confirms that public key certificate  $Cert-A$  of home server 2001 is not revoked, using

the CRL (S2109).

If revoked (S2110 = NO), authentication unit 2203 ends the processing.

If not revoked (S2110 = YES), authentication unit 2203  
5 verifies public key certificate Cert-A using public key PK-CA (S2111).

If verification fails (S2112 = NO), authentication unit 2203 ends the processing.

If verification succeeds (S2112 = YES), authentication  
10 unit 2203 generates a random number  $y'$  (S2113), and signature data  $S1 = \text{Sig}(SK - i, (y' * G) \parallel x)$  (S2114) and outputs  $y' * G$  and  $S1$  to authentication unit 2103 (S2115).

Authentication unit 2103 receives  $y' * G$  and  $S1$  from authentication unit 2103 (S2115).

15 Authentication unit 2103 verifies  $S1$  (S2116).

If verification fails (S2117 = NO), authentication unit 2103 ends the processing.

If verification succeeds (S2117 = YES), authentication unit 2103 generates a random number  $x'$  (S2118) and signature  
20 data  $S0 = \text{Sig}(SK - i, (x' * G) \parallel x)$  (S2119), and outputs  $x' * G$  and  $S0$  to authentication unit 2203 (S2120).

Authentication unit 2203 receives  $x' * G$  and  $S0$  from authentication unit 2103 (S2120), and verifies  $S0$  (S2121).

If verification fails (S2122 = NO), authentication unit

2203 ends the processing.

If verification succeeds (S2122 = YES), authentication unit 2203 calculates a session key  $K' = y' \cdot (x' * G)$  (S2124).

On the other hand, authentication unit 2103 calculates  
5 a session key  $K = x' \cdot (y' * G)$  (S2123).

In this way, mutual device authentication and key sharing are conducted between home server 2001 and playback apparatus 2002.

Session keys  $K$  and  $K'$  are keys having the same value  
10 shared in home server 2001 and playback apparatus 2002.

#### 4.3.3 Duplication Processing

Fig.42 is a flowchart showing duplication processing

The following description relates to an example in  
15 which the request apparatus, the delivery apparatus and the other apparatus in Fig.42 are playback apparatus 2002, home server 2001, and playback apparatus 2003, respectively.

The delivery apparatus, the request apparatus, and the other apparatus conduct the duplication-source  
20 determination processing shown in Fig.42 (S2201).

In the given example, the request apparatus selects home server 2001 as the delivery apparatus (i.e. duplication source), as a result of the duplication-source determination processing.

The request apparatus transmits a duplication request that includes confirmation information identifying a content targeted for duplication and attribute information showing "apparatus" or "medium" to the delivery apparatus (S2202).

5       The delivery apparatus receives the duplication request, and holds the received duplication request together with the IP address of the request apparatus.

The delivery apparatus and the request apparatus conducted the mutual authentication and key sharing shown  
10 in Figs.43 and 44 (S2203).

The delivery apparatus and request apparatus share session keys as a result of the step S2203 processing.

After completion of the session key sharing, communication between the delivery apparatus and the request  
15 apparatus is encrypted/decrypted using the session keys.

The request apparatus transmits group affiliation information to the delivery apparatus (S2204).

The request apparatus judges whether the received group affiliation information matches group affiliation  
20 information held by authentication unit 2103 (S2205).

When the mutual authentication and key sharing at step S2203 are successful, the delivery apparatus generates request management information based on the held duplication request and IP address, and the step 2205 judgment result,



and adds the generated request management information to the management request queue (S2206).

The delivery apparatus waits for the request management information added at step S2206 to be at the head of the queue  
5 (S2207).

When the request management information is at the head of the queue, the delivery apparatus restarts the duplication processing based on the request management information.

The delivery apparatus selects a target remaining  
10 number based on the attribute information and in/out group information included in the request management information, and judges whether the target remaining number is "0" (S2208).

The target remaining number is one selected from the  
15 in-group and out-group apparatus/medium remaining numbers.

When the in/out group information shows "in-group" and the attribute information shows "apparatus", the target remaining number will be the in-group apparatus remaining number.

20 Likewise, when the in/out group information shows "out-group" and the attribute information shows "apparatus", the target remaining number will be the out-group apparatus remaining number.

When the in/out group information shows "in-group" and

the attribute information shows "medium", the target remaining number will be the in-group medium remaining number.

5 When the in/out group information shows "out-group" and the attribute information shows "medium", the target remaining number will be the out-group medium remaining number.

10 When the target remaining number is "0" (S2208 = YES), the delivery apparatus transmits a duplication permission notification to the request apparatus showing "duplication not permitted" (S2209).

The request apparatus judges whether a duplication permission notification showing "duplication not permitted" has been received from the delivery apparatus (S2210).

15 When judged that such a duplication permission notification has been received (S2210 = YES), the request apparatus ends the processing.

20 When the target remaining number is not "0" (S2208 = NO), the delivery apparatus encrypts the content using the session key (S2211), and transmits the encrypted content to the request apparatus (S2212).

The request apparatus decrypts the encrypted content received from the delivery apparatus using the session key, and hold the decrypted content in storage unit 2207 (S2213).

The request apparatus transmits a duplication-completed notification to the delivery apparatus (S2214).

The delivery apparatus receives the  
5 duplication-completed notification from the request apparatus and subtracts "1" from the target remaining number (S2215).

The delivery apparatus deletes the request management information at the head of the request management queue to  
10 update the request management queue (S2216).

#### 4.3.4 Duplication-Restriction Information (DRI) Transfer Processing

Another apparatus is able to possess rights permitting  
15 the duplication of the content as a result of the delivery apparatus transferring DRI information managed therein.

Fig.46 is a flowchart showing DRI transfer processing.

In the given example, the request apparatus, the delivery apparatus, and the other apparatus are playback  
20 apparatus 2002, home server 2001, and playback apparatus 2003, respectively.

When a plurality of possible transfer-source apparatuses is operational over a network, the request apparatus firstly determines which one of these apparatuses  
25 to request for transfer.

The request apparatus broadcast transmits, over the network, a duplication number transfer request that includes confirmation information identifying a targeted content and duplication request number relating to transfer (S2301).

5       The duplication request number is an 8-digit number, and in the given example, from a head, the first 2 digits are the in-group apparatus remaining number, digits 3 and 4 are the out-group apparatus remaining number, digits 5 and 6 are the in-group medium remaining number, and digits 7 and  
10   8 are the out-group medium remaining number.

For example, if the in-group apparatus remaining number is "80", the out-group apparatus remaining number is "2", the in-group medium remaining number is "50", and the out-group medium remaining number is "3", the duplication  
15   request number will be "80025003".

When the delivery apparatus manages the content identified by the broadcasted confirmation information, and also holds the in-group and out-group apparatus/medium remaining numbers included in the duplication request number,  
20   the delivery apparatus judges the content to be transferable, and judges the content to be untransferable in any other case (S2302).

When judged to be untransferable (S2302 = NO), the delivery apparatus ends the processing.

Likewise, when the other apparatus manages the content identified by the broadcasted confirmation information, and also holds the in-group and out-group apparatus/medium remaining numbers included in the duplication request number, 5 the other apparatus judges the content to be transferable, and judges the content to be untransferable in any other case (S2303).

When judged to be untransferable (S2303 = NO), the other apparatus ends the processing.

10 The delivery apparatus, when judged to be transferable (S2302 = YES), transmits a transfer permission notification to the request apparatus showing "transfer permitted" (S2304).

The other apparatus, when judged to be transferable 15 (S2303 = YES), transmits a transfer permission notification to the request apparatus showing "transfer permitted" (S2305).

The request apparatus confirms the content of received transfer permission notifications, and hold the 20 transmission-source IP address of apparatuses that transmitted transfer permission notification showing "transfer permitted" (S2306).

The request apparatus transmits an ICMP echo request message to the apparatuses whose IP address is being held,

and measures the round-trip response times from the transmission time until receipt of the ICMP echo reply messages.

The request apparatus transmits an ICMP echo request  
5 message to the delivery apparatus (S2307).

The delivery apparatus receives the ICMP echo request message, and transmits an ICMP echo reply message to the request apparatus as a response (S2308).

The request apparatus receives the ICMP echo reply  
10 message, and calculates the round-trip time.

The request apparatus transmits an ICMP echo request message to the other apparatus (S2309).

The other apparatus receives the ICMP echo request message, and transmits an ICMP echo reply message to the  
15 request apparatus as a response (S2310).

The request apparatus receives the ICMP echo reply message, and calculates the round-trip time.

The request apparatus selects the apparatus having the shortest round-trip time as the transfer-source apparatus  
20 (S2311).

The request apparatus holds the IP address of the transfer-source apparatus.

In the given example, the request apparatus selects the delivery apparatus as the transfer-source apparatus.

The request apparatus and the delivery apparatus conduct the mutual authentication and key sharing shown in Figs.43 and 44 (S2312).

The delivery apparatus and the delivery apparatus share  
5 session keys as a result of the S2312 processing.

After completion of the session key sharing, communication between the delivery apparatus and the request apparatus is encrypted/decrypted using the session keys.

The request apparatus transmits group affiliation  
10 information and the duplication request number to the delivery apparatus (S2313).

The delivery apparatus confirms whether the received group affiliation information matches group affiliation information held by authentication unit 2103, and judges the  
15 delivery apparatus to be in-group if matched and out-group if not matched (S2314).

When judged to be in-group (S2314 = YES), the delivery apparatus subtracts the remaining numbers shown by the duplication request number from the in-group and out-group  
20 apparatus/medium remaining numbers, respectively (S2315).

For example, if the in-group apparatus remaining number held by the delivery apparatus is "99", the out-group apparatus remaining number is "10", the in-group medium remaining number is "99", and the out-group medium remaining

number is "10", and the duplication request number is "30051001", the delivery apparatus will hold, after the execution of step S2315, "69" as the in-group apparatus remaining number, "5" as the out-group apparatus remaining  
5 number, "89" as the in-group medium remaining number, and "9" as the out-group medium remaining number.

The delivery apparatus sets a transfer duplication number to "30051001".

When the request apparatus is judged to be out-group  
10 (S2314 = NO), the delivery apparatus sets the transfer duplication number to "0".

The delivery apparatus transmits a transfer permitted notification that includes the transfer duplication number and usage period information held by the delivery apparatus  
15 (S2316).

The request apparatus judges whether the received transfer duplication number is "0" (S2317).

When judged to be "0" (S2317 = YES), the request apparatus ends the processing.

20 When judged to not be "0" (S2317 = NO), DRI management unit 2202 in the request apparatus sets the confirmation information as a content ID, and holds, as duplication-restriction information, the content ID, the transfer duplication number and the usage period information



in correspondence with each other (S2318).

#### 4.3.5 Usage Period Management Processing

The following description relates to processing when  
5 a delivery apparatus duplicates a content having a  
predetermined usage expiry date-time to a request apparatus.

When the clocks included in the delivery apparatus and  
the request apparatus reach the time shown by the usage expiry  
date-time, the request apparatus deletes the content, and  
10 the delivery apparatus conducts processing to increase the  
remaining number of permitted duplications corresponding to  
the deleted content.

Fig.47 is a flowchart showing usage period management  
processing to manage contents whose usage expiry date-time  
15 has been determined.

In the given example, the delivery apparatus and  
request apparatus in Fig.47 are home server 2001 and playback  
apparatus 2002, respectively.

Content duplication as shown in Fig.45 is conducted  
20 between the delivery apparatus and the request apparatus  
(S2401).

In the given example, the delivery apparatus transmits  
usage period information to the request apparatus at a time  
of transmitting the content to the request apparatus at step

2212.

The request apparatus holds the received usage period information.

The delivery apparatus instructs time management unit  
5 2105 to output a notification when the clock in time management unit 2105 shows the usage expiry date-time in the usage period information (S2402).

When there is a notification from time management unit 2105 (S2402 = YES), the request apparatus adds "1" to the  
10 remaining number corresponding to the request apparatus (S2403).

For example, when the request apparatus is an in-group apparatus, the delivery apparatus adds "1" to the in-group apparatus remaining number in the duplication-restriction  
15 information, and when the request apparatus is an out-group apparatus, the delivery apparatus adds "1" to the out-group apparatus remaining number in the duplication-restriction information.

When there is a notification from time management unit  
20 2205 (S2404 = YES), the request apparatus deletes the content corresponding to the usage period information (S2405).

#### 4.3.6 Duplication Reservation Processing

Fig.48 is a flowchart showing duplication reservation

processing.

The delivery apparatus, the request apparatus, and the other apparatus conduct the duplication-source determination processing shown in Fig.42 (S2501).

5 In the given example, the delivery apparatus, the request apparatus, and the other apparatus are home server 2001, playback apparatus 2002, and playback apparatus 2003, respectively.

Also, the request apparatus selects the delivery  
10 apparatus as the duplication source, as a result of the S2501 processing.

The delivery apparatus holds the confirmation information identifying the content targeted for duplication, acquired at step S2501.

15 The request apparatus transmits a duplication reservation request to the delivery apparatus that includes a duplication start time at which to actually start the duplication (S2502).

The delivery apparatus receives the duplication  
20 reservation request, and timer-sets time management unit 2105 to detect when the duplication start time is reached (S2503).

The delivery apparatus detects, in time management unit 2105, the duplication start time being reached (S2504).

The request apparatus and the delivery apparatus execute the processing from step S2203 in Fig.45 (S2505).

#### 4.3.7 Return Processing

5        After conducting content duplication from the delivery apparatus to the request apparatus, deletion of the content in the request apparatus and adding "1" to both the remaining number corresponding to the deleted content and the duplicable number of the content in the delivery apparatus  
10    is referred to as "return processing".

Fig.49 is a flowchart showing return processing.

In the given example, the request apparatus and the delivery apparatus are playback apparatus 2002 and home server 2001, respectively.

15        Also, the delivery apparatus duplicates a content to the request apparatus.

The request apparatus transmits a return request to the delivery apparatus that includes confirmation information identifying the content for return (S2601).

20        The delivery apparatus holds the received return request.

The request apparatus and the delivery apparatus execute the mutual authentication and key sharing shown in Figs.43 and 44 (S2602).

The request apparatus shares session keys with the delivery apparatus as a result of the S2602 processing.

The request apparatus transmits group affiliation information to the delivery apparatus (S2603).

5       The delivery apparatus investigates whether the received group affiliation information matches group affiliation information held by the delivery apparatus, and judges the request apparatus to be in-group when matched and to be out-group when not matched (S2604).

10       When judged that the request apparatus is out-group (S2604 = NO), the delivery apparatus transmits an error notification to the request apparatus (S2605), and ends the processing.

      When an error notification is received (S2606 = YES),  
15   the request apparatus ends the processing.

      When judged that the request apparatus is in-group (S2604 = YES), the delivery apparatus converts a format of the return request, and queues the converted return request in the request management queue as request management  
20   information (S2607).

      The delivery apparatus detects when the request management information relating to the return request is at the head of the request management queue (S2608).

      When detected that the return request is at the head

of the request management queue (S2608 = YES), the delivery apparatus transmits a return processing start notification to the request apparatus that includes the confirmation information (S2609).

5        Having received the return processing start notification, the request apparatus deletes the content identified by the confirmation information included in the received notification (S2610).

      The request apparatus transmits a deletion-completed  
10 notification to the delivery apparatus that includes the confirmation information (S2611).

      The delivery apparatus adds "1" to the target remaining number corresponding to the deleted content (S2612).

      The delivery apparatus deletes the return request from  
15 the head of the request management queue to updates the request management queue (S2613).

#### 4.4 Variations

(1) Although the above AD server-related variation was  
20 described in terms of a recording medium being connected to a home server via an apparatus, a medium insertion opening may be provided in the home server, and mutual authentication, content duplication and the like conducted when the home server is connected to the recording medium inserted in the

insertion opening.

While direct connection between the recording medium and the home server is different to connection via a playback apparatus and a network, differences do not arise in the  
5 methods of mutual authentication, content duplication and the like.

(2) In order to determine a content distribution source, CDS determining unit 2206 need not use ICMP echo response and rely messages.

10 CDS determining unit 2206 may prestore an information processing capability of each apparatus, and determine the apparatus having the highest information processing capability from among those apparatuses responding to a broadcast to be the distribution source.

15 Also, CDS determining unit 2206 may preset a priority level for each apparatus, and select the apparatus having the highest priority level from among those apparatuses responding to a broadcast to be the distribution source.

(3) Although the above was described in terms of the  
20 duplication-restriction information including usage period information, content duplication restrictions may be added using other information.

For example, a duplication-restriction information (DRI) management unit may hold area restriction information.

Area restriction information is information showing an area in which it is permissible to duplicate a content.

Here, the area restriction information can take, for example, a value of "1" showing Japan, a value of "2" showing the United States, and a value of "3" showing Germany.

When a value of the area restriction information is "1", content duplication is restricted to only apparatus within Japan.

Also, a DRI management unit may hold a revocation list.

The revocation list is a list apparatuses to which content duplication permission is not given.

DRI management unit 2102 does not give permission for content duplication to apparatuses shown in the revocation list.

Also, a DRI management unit may hold duplication generation information.

Duplication generation information shows how many times a content can be duplicated.

For example, with a content having duplication generation information that shows "2", duplication is permitted up to a second-generation copy.

(4) The content duplication management system may collaborate with an accounting system.

In this case, the present system transmits an



accounting request to the accounting system when judged to give content duplication permission to an out-group apparatus.

A user of the content and an accounting amount are  
5 included in the accounting request.

The accounting system enters into a contract with the content user in advance, when accounting arises, the accounting system enters into a contract for reimbursement or the like using a credit card, for example.

10 When reimbursement processing is performed smoothly, the accounting system notifies a server of completion of the reimbursement processing.

On receiving the reimbursement-processing completed notification, the server conducts content duplication after  
15 giving content duplication permission to the request apparatus.

Also, accounting may also be conducted every time content duplication is conducted, even within a homework network.

20 (5) Although the above was described in terms of playback apparatus 2002 receiving transfer of rights permitting content duplication from home server 2001, playback apparatus 2002 may operate as a backup device when home server 2001 is unable to operate.

(6) The above was described in terms of in-group and out-group apparatus/medium remaining numbers being managed as duplication-restriction information. However, for management purposes, a total of the in-group apparatus remaining number and the in-group medium remaining number may be managed as an "in-group remaining number", and a total of the out-group apparatus remaining number and the out-group medium remaining number may be managed as an "out-group remaining number", without distinguishing between apparatuses and recording mediums.

(7) Although the above was described in terms of a home server acquiring duplication-restriction information via a network as compared with a broadcast, the acquisition route is not limited to a network.

A broadcast station may transmit duplication-restriction information by a broadcast, and a home server may acquire the duplication-restriction information by receiving the broadcast.

(8) Although the above was described in terms of a request apparatus broadcast transmitting a confirmation request over a network as part of the duplication-source determination processing, other means apart from a broadcast may be used.

For example, when candidates for being the

distribution-source apparatus are predetermined, the request apparatus may multicast transmits the confirmation request.

(9) The above was described in terms of a DRI management unit conducting processing on request management information at the head of the request management queue. However, when the remaining number (i.e. one of the in-group and out-group apparatus/medium remaining numbers) relating to request management information included at the head of the queue is "0" and processing shown by the processing classification cannot be executed, the request management information that is included in a position other than the head of the queue, and whose processing classification shows "delete" may be processed first.

Since "1" is added to the remaining number as a result of processing being conducted that prioritizes the request management information whose processing classification shows "delete", a DRI management unit is able to conduct processing related to request management information included at the head of the queue.

## 5. Further Variations

While the present invention has been described above based on the above embodiment, the present invention is of

course not limited to this embodiment. Variations such as those described below are also included in the present invention.

- 5 (1) Although in the above embodiment, CSI is copied using IC card 400 at a time of registering a device not connected to AD server 100, CSI may be transferred from client device to client device directly without using IC card 400.

The transfer of CSI from playback apparatus 200 to a  
10 playback apparatus 200n, and the registration of playback apparatus 200n as a device within the authorized domain managed by AD server 100 will now be described as an example.

Playback apparatus 200 and playback apparatus 200n are connected, and playback apparatus 200n is operated to  
15 transmit a transfer request to playback apparatus 200. Playback apparatus 200 and playback apparatus 200n establish a SAC and generate session key *SK*. Playback apparatus 200 encrypts CSI with the session key *SK* and transmits the encrypted CSI to playback apparatus 200n. Playback apparatus  
20 200n decrypts the encrypted CSI using the session key, stores the CSI, and stores the ID of playback apparatus 200, which is the transfer source, received at a time of establishing the SAC. Also, playback apparatus 200n transmits a receipt notification to playback apparatus 200. Playback apparatus

200, on receipt of the receipt notification, deletes the CSI in CSI storage unit 208 and stores "0" in CSI storage unit 208.

Playback apparatus 200n when connected to AD server 100 and when a SAC is established, notifies AD server 100 of the CSI transfer, transmits the ID of the transfer source and the ID of playback apparatus 200n to AD server 100, and AD server 100 rewrites DEVICE ID in the registration information.

10

(2) Although in the above embodiment, IC card 400 is affiliated with AD server 100, IC card 400 need not be affiliated.

In this case, as with other client devices, IC card 400 establishes a SAC when connected to AD server 100, registers ID\_4 as a device ID, and acquires CSI.

AD server 100, at a time of recording a content key onto DVD 500, encrypts the content key using an encryption key generated by concatenating ID\_4 of IC card 400 and CSI.

20 On-vehicle device 300, when DVD 500 is mounted therein and when IC card 400 is connected, establishes a SAC with IC card 400 and shares session key SK.

IC card 400 concatenates ID\_4 and CSI stored in IC card 400 to generate a decryption key, encrypts the decryption

key using session key *SK* to generate an encrypted decryption key, and transmits the encrypted decryption key to on-vehicle device 300.

On-vehicle device 300 decrypts the encrypted  
5 decryption key using session key *SK* to obtain a decryption key, decrypts the encrypted content key read from DVD 500 using the decryption key to obtain a content key, decrypts an encrypted content using the content key to obtain a content, and plays the content.

10 Also, the same processing as in (1) above to transfer CSI between client devices may be conducted to transfer CSI from an IC card to on-vehicle device 300. In this case, an IC card not affiliated with AD server 100 may, as with IC card 400 in embodiment 1, be provided with the function of  
15 notifying AD server 100 of a transfer. In this case, an IC card that transfers CSI to on-vehicle device 300 prohibits the transfer of CSI without immediately deleting the CSI, and deletes the CSI after notifying AD server 100 of the transfer.

20

(3) When registering a device not connected to AD server 100 using IC card 400, a permission right or CSI may be transmitted from AD server 100 to IC card 400 via a network.

As one example, when IC card 400 is connected to a client

device such as a PC or the like that is connected to a network and has a communication function, IC card 400 conducts SAC establishment processing and receives a permission right or CSI using the communication function of the PC.

5       The client device having the communication function is not limited to being a PC, and may be a personal digital assistant (PDA), a mobile telephone or the like.

(4)   In the above embodiment, contents are either delivered  
10   from AD server 100 to a client device or recorded onto a DVD and distributed from AD server 100 to a client device. However, a SAC may be established between client devices and session key *SK* generated, and contents delivered from one client device to another client device.

15

(5)   In the above embodiment, on-vehicle device 300 is registered using IC card 400. However, withdrawal processing may be conducted in the same way using IC card 400.

      In this case, on-vehicle device 300, which has IC card  
20   400 connected thereto, is operated to transmit a withdrawal request to IC card 400, and IC card 400 establishes a SAC to confirm that on-vehicle device 300 is registered, and transmits a deletion notification to on-vehicle device 300. On-vehicle device 300 deletes the CSI, and transmits a

deletion-completed notification to IC card 400. IC card 400,  
on receipt of the deletion-completed notification, stores  
the ID of the withdrawn on-vehicle device 300. IC card 400,  
when connected to AD server 100, notifies AD server 100 that  
5 on-vehicle device 300 has withdrawn and of the ID of  
on-vehicle device 300. AD server 100 deletes the ID of  
on-vehicle device 300 from DEVICE ID in the registration  
information, subtracts "1" from the registered number, and  
adds "1" to the remaining number.

10

(6) In the above embodiment, AD server 100 confirms whether  
a target device is registered or unregistered by a value of  
CSI stored by the target device, using signature verification  
at a time of establishing a SAC. However, AD server 100 may  
15 confirm that a target device is registered or unregistered  
by receiving an ID from the device to be authenticated, and  
judging whether the received ID is stored in DEVICE ID in  
the registration information. Also, all of the client devices  
registered as devices within the authorized domain of AD  
20 server 100 may store the registered IDs, and confirm whether  
other client devices are registered or unregistered by using  
the IDs in the same way as described above.

(7) In the above embodiment, IC card 400 is used at a time



of registering a device that is not connected to AD server 100. However, AD server 100 may display CSI on display unit 114, and a user may manually input the CSI into a client device. In this case, a code to be inputted may be a value obtained  
5 by encrypting CSI, depending on the device, the session, and so forth.

(8) In the above embodiment, at a time of establishing a SAC and encrypting and transmitting CSI, signature data of  
10 the device transmitting the encrypted CSI may be appended to the ciphertext.

(9) In the above embodiment, registration information and CSI is stored internally in respective devices. However,  
15 registration information and CSI may be stored in a removable memory area that cannot be read, written or copied without permission.

(10) In the above embodiment, the ID of a device and CSI or  
20 a random number and CSI are concatenated for use as an encryption key at a time of encrypting a content, and as a decryption key at a time of decrypting the encrypted content key. However, the present invention is not limited to this, and an operation may be conducted using the ID of a device

and CSI or a random number and CSI, and the resulting value used.

(11) Although in the above embodiment, a maximum number, a registered number and a remaining number are managed as registration information, the present invention is not limited to this.

The maximum number may be set as the initial value of the remaining number and "1" subtracted from the remaining number every time a device is registered, and a client device may be registered if the remaining number is not "0". Also, the maximum number and the registered number may be managed, and a client device registered if the registered number is less than the maximum number.

15

(12) The maximum number, the registered number, and the like may be managed after dividing the number of devices in the registration information into devices connected online to AD server 100 and devices registered using IC card 400.

20

(13) Although in the above embodiment, AD server 100 conducts management based on stored registration information, a separate management authority may be provided and structured as in (a) to (c) below.

(a) The management authority sets the maximum number of registerable devices, appends signature data of the management authority to the maximum number, and either records the maximum number onto a portable recording medium  
5 such as a DVD for distribution or distributes the maximum number via a communication channel. AD server 100 verifies the signature data, and if verification is successful, stores the maximum number as MAXIMUM in the registration information.

10 (b) AD server 100 requests the management authority for the number of devices that AD server 100 seeks to register. The management authority conducts accounting in response to the number of devices, and if the accounting is successful, transmits information to AD server 100 permitting  
15 registration of the requested number of devices, and AD server 100, on receipt of the information, accepts the registration of client devices within the permitted number.

(c) AD server 100 sends out a request to the management authority every time a registration is received from a client  
20 device, and the management authority conducts accounting in response to the request, and permits the registration if the accounting is successful. AD server 100, when registration is permitted, registers the client device and transmits CSI to the client device.

(14) In the above embodiment, playback apparatus 200 plays contents delivered from AD server 100. However, playback apparatus 200 may have a DVD playback function, and play  
5 contents recorded onto DVD 500 by AD server 100.

Also, in the above embodiment, AD server 100 joins each of the device IDs stored in the registration information with CSI and uses the result in the encryption of content keys. However, AD server 100 may prestore the ID of devices having  
10 a DVD playback function, extract the ID of the devices capable of playing DVD, and concatenate each of these IDs with CSI for use in the encryption of content keys.

(15) Although in the above embodiment, AD server 100 records  
15 contents onto a DVD, contents may be recorded onto a memory card, an MD, an MO, a CD, a BD (blu-ray disk) or the like, or onto an IC card.

Also, apart from a playback apparatus, a client device may be a recording device or a combination of a playback  
20 apparatus and a recording device. Also, a client device may, apart from being installed in a user's home or mounted in a vehicle, be a portable device capable of being carried by a user.

(16) IC card 400, because of being connected directly to AD server 100 or on-vehicle device 300, need not conduct SAC establishment processing.

5 (17) In the above embodiment, signature data, at a time of establishing a SAC, is generated with respect to data in which CSI is concatenated to random numbers *Cha\_B* or *Cha\_A*. However, a hash value of data that is to be a signature target may be calculated, and signature data may be generated with  
10 respect to this hash value.

(18) In the above embodiment, at a time of establishing a SAC, CSI is used when judging whether a device targeted for authentication is registered or unregistered and when  
15 sharing keys. However, CSI need only be used in one of these cases.

Also, although in the above embodiment, authentication is conducted in both directions (i.e. mutually), authentication may be only unidirectional.

20

(19) Registration of client devices may be restricted by time.

In this case, the time between AD server 100 and a client device is synchronized. AD server 100 sets a time period

within which use of CSI is permitted as valid period information, transmits the valid period information and CSI to the client device, and add "1" to the registered number.

The client device receives and stores the valid period  
5 information and the CSI. When the period shown by the valid period information ends, the client device deletes the CSI.

AD server 100, once the period shown by the valid period information has ended, subtracts "1" from the registered number. If storing the device ID, AD server 100 deletes the  
10 ID of the device whose valid period has expired.

Moreover, the usage period information may show a date-time of the start/end of a usage period, or only the end date-time. Also, the usage period information may be information that sets restrictions on a period from the start  
15 of CSI usage, or may set restrictions on a period of operations by a client device using the CSI.

(20) Although there is a single AD server per authorized domain in the above embodiment, there may be a plurality of  
20 AD servers in a single authorized domain.

In this case, a client device is able to select which of the AD servers to communicate with. As a selection method, a user may make a setting, or a client device may select the AD server closest in the authorized domain to the client

device in terms of distance. Also, a client device may select the AD server having the highest processing capacity or a low number of other tasks.

Also, as described below, an AD server requested for  
5 registration by a client device may, when unable to register the client device and the like, search for another AD server that is able to register the client device.

Specifically, the client device transmits a registration request to an AD server. When the registered  
10 number in the requested AD server matches the maximum number, the requested AD server makes inquiries with another AD server as to whether the other AD server can register the client device. The other AD server, when able to register the client device, registers the client device that requested  
15 registration and notifies the requested AD server that registration is possible, and the requested AD server, on receipt of the notification, transmits CSI to the client device.

Also, if the other AD server replies that registration  
20 of the client device is not possible, the AD server makes inquiries with yet another AD server.

Also, one AD server may be selected to represent a plurality of AD servers, and the representative server may manage all of the in-group devices. In this case, when an

AD server other than the representative server receives a registration request from a client device, the AD server inquires as to whether the client device is registerable in the representative server, and if registerable, the client  
5 device is registered in the representative server, and receives CSI from the representative server via the AD server that received the request.

Moreover, if the representative server is currently conducting other operations, or the like, the AD server may  
10 inquire with the other AD servers as to whether any of these other AD servers are able to register the client device.

Also, as shown in (a) and (b) below, since a registered number of devices is managed among a plurality of AD servers, the AD servers may share a list relating to registered  
15 devices.

(a) When AD servers R and S within the same authorized domain each register client devices, the ID of registered devices are stored as a device list. Also, whenever a list is updated by writing in IDs, the IDs are stored in the device  
20 list in correspondence with a version number.

AD servers R and S exchanges device lists regularly or irregularly. AD server R compares the version number of the device list stored therein with the version number of the device list stored by AD server S, and stores the device list



having the latest version number. AD server S conducts the same processing. In this way, it is possible for AD servers to always share the latest device list.

Moreover, device lists may be exchanged every time the  
5 device list of one of the AD servers is updated. Also, registration information such as registered numbers and maximum numbers may be shared in the same way as above.

(b) AD servers T and U within the same authorized domain hold device lists T and U, respectively, and at a time of  
10 registering a client device, store the device IDs of the client devices in correspondence with a registration time. AD servers T and U exchange device lists regularly or irregularly.

AD server T, if the registered number stored therein  
15 as registration information is less than the maximum number, writes client devices newly registered in device list U received from AD server U into device list T stored therein, in the order of registration. Also, AD server U, in the same way, receives device list T, and updates device list U in  
20 the order in which new client devices were registered.

Moreover, client devices may be provided in advance with a priority level, and priority can be given to the registration of devices having a high priority level. Also, when the combined number of client devices newly registered

in AD servers T and U exceeds the maximum number, priority may be given to the registration of devices having a high priority level, or a user may select devices to be registered.

5       According to this method, even if the requested AD server is in a power-OFF state, a client device can be registered in another AD server, and consistency maintained by exchanging device lists when the other server is updated, thus making it possible for AD servers to share the same device  
10   list.

(21) In order to avoid duplication of CSI among different authorized domains, information exchange may be conducted between AD servers managing the different authorized domains,  
15   and confirmation made as to whether or not there is duplication.

Also, in order to improve safety, the AD servers may input respective CSI into a hash function to calculate a hash value, and exchange the hash values to confirm whether or  
20   not there is duplication.

Also, instead of AD servers generating CSI, a management authority may be provided, and the management authority may generate the CSI of all of the authorized domains so as to avoid duplication, and send respective CSI

to the AD servers in a safe manner.

(22) Client devices may belong to a plurality of authorized domains.

5       The number of authorized domains in which a client device can register may be restricted by restricting the number of pieces of CSI that the client device is able to store. Also, the present invention may be structured such that the number of authorized domains in which a client device  
10   can register is restricted by AD servers exchanging list information that shows registered client devices. Also, exchanging list information makes it is possible to confirm the number of authorized domains to which client devices belong.

15       Otherwise, a management authority may be provided for managing the number of authorized domains in which a client device registers.

Also, a single AD server may manage a plurality of authorized domains. In this case, the number of pieces of  
20   different CSI that an AD server can store is restricted, and the AD server can manage authorized domains within this number. Also, the AD server may store the registerable number of client devices per piece of CSI, or may store pieces of CSI in correspondence with group IDs.

(23) Authorized domains may each be allotted an identifier, and at a time of delivering a content, the device delivering the content may embed the identifier of the authorized domain in which the device is registered in the content as an electronic watermark.

In this way, it is possible to specify which authorized domain the content issued from, in the event of a content decrypted by a client device being improperly distributed outside of the authorized domain within which it originated. Furthermore, when a server that delivered the content manages the ID of client devices registered in various authorized domains, the ID of the client device that issued the content may be included in the CRL.

15

(24) Although in the above embodiment, contents are delivered to a device after successfully authenticating the device, the present invention is not limited to this.

Authentication need not be conducted at a time of content delivery in the following cases.

20

A device on the content transmission end generates an encryption key based on CSI, encrypts a content key using the generated encryption key, and transmits the encrypted content key and an encrypted content that was encrypted using

the content key.

A device on the receiving end, on acquiring the encrypted content and encrypted content key, generates based on the CSI, a decryption key the same as the encryption key,  
5 decrypts the encrypted content key using the decryption key to obtain a content key, and decrypts the encrypted content using the content key to obtain a content.

In this way, only a device that holds the CSI can generate the decryption key and decrypt the encrypted  
10 content.

Also, when an encrypted content is delivered first without authentication being conducted, and then authentication, as in the above embodiment, is conducted later to share a session key, and authentication is  
15 successful, the content key may be encrypted using the session key and delivered.

Moreover, the delivery of an encrypted content may be conducted by communication, or by recording the encrypted content onto a portable recording medium.

20 Also, even when there is no content delivery request or the like from a device on the receiving end, a device on the transmitting end may judge to conduct content delivery or the like, or may conduct content delivery or the like in accordance with an input from outside.

(25) In the above embodiment, a CSI storage unit stores "0" as an initial value, and on receipt of CSI generated by AD server 100, overwrites the initial value with the acquired  
5 CSI. However, the initial value and the CSI may be stored in separate areas. Also, when the acquired CSI is stored in a separate area to the initial value, the initial value may be deactivated.

Moreover, the deactivated initial value may be  
10 reactivated at a time of deleting CSI due to a transfer, withdrawal, or the like.

Moreover, although the above was described in terms of "0" being stored as a value showing "unregistered", this value need not be "0", and may be any value that differs from  
15 the value generated as CSI.

(26) Although in the above embodiment, AD server 100 permits IC card 400 to copy CSI one time, AD server 100 may permit a plurality of copies.

20 Also, IC card 400 may prevent CSI from being copied to the same client device more than once by, in addition to authenticating client devices using the CSI, storing the ID of client devices to which the CSI has been copied, and confirming the ID of client devices at a time of copying.

Also, an IC card may be implemented with the function of registering client devices, and a device connected to the IC card may operate as an AD server.

Also, a client device may be registered in an AD server  
5 as representing a plurality of client devices, and receive the right to copy CSI to the plurality of client devices. An example of this is shown using Fig.50.

An AD server 600 and a client device 601 are disposed in the home of a user, and client device 601 is already  
10 registered in AD server 600. AD server 600 stores a maximum number and a remaining number as registration information, the maximum number and remaining number in the given example being 4 and 3, respectively.

On-vehicle devices 602, 603 and 604, which are not  
15 registered in AD server 600, are mounted in a vehicle owned by the user. On-vehicle devices 603 and 604 do not function to communicate directly with AD server 600. On-vehicle device 602 is portable and does function to communicate directly with AD server 600. Also, on-vehicle devices 602, 603 and  
20 604 are connected to and can communicate with each another.

On-vehicle device 602, when connected to AD server 600 as a representative on-vehicle device, transmits a registration request to AD server 600 that includes a desired number "3", which is the number of client devices on-vehicle

device 602 seeks to register.

AD server 600, on receipt of the registration request, authenticates on-vehicle device 602 and shares a session key, the same as in the above embodiment. If authentication is  
5 successful, AD server 600 judges whether the desired number in the registration request is less than or equal to the remaining number stored as registration information. If judged to be less than or equal to the remaining number, AD server 600 reads the stored CSI, encrypts the read CSI and  
10 permission right permitting the registration of three devices, using the session key, and transmits the encrypted CSI and the encrypted permission right to on-vehicle device 602 as encrypted rights information.

On-vehicle device 602, on receipt of the encrypted  
15 rights information, decrypts the encrypted CSI and permission right using the session key to obtain CSI and a permission right. Also, because 1-device worth of the permission right is used in storing the obtained CSI, the permission right stored shows two devices to be registerable.  
20 Also, on-vehicle device 602 conducts authentication with on-vehicle devices 603 and 604, and if successful, transmits the CSI to on-vehicle devices 603 and 604 and reduces the number of registerable devices shown in the permission right.

In this way, on-vehicle devices 603 and 604 can be



registered as client devices.

Moreover, if the remaining number is less than the desired number, AD server 600 transmits a permission right permitting the registration of devices equal to the remaining  
5 number. As an example, when a permission right permitting the registration of two devices is transmitted, on-vehicle device 602 uses the permission right for 1 device in storing the obtained CSI, and uses the remaining permission right for 1 device by transmitting the CSI to one of on-vehicle  
10 devices 603 and 604. The device to which the CSI is transmitted may be selected by the user, or each device may have a priority level, and the CSI transmitted to the device having the higher priority level.

Also, at a time of registering on-vehicle devices 602,  
15 603 and 604 in AD server 600, the following processing is conducted when registering an ID of each on-vehicle device in AD server 600.

On-vehicle device 602, before registering, acquires the IDs of on-vehicle devices 603 and 604. On-vehicle device  
20 602, at a time of registering, transmits the acquired IDs and the ID of on-vehicle device 602 to AD server 600. AD server 600 stores the received IDs as device IDs. Also, if the remaining number is less than the desired number, AD server 600 stores, from the received IDs, IDs for how ever many

devices is shown by the remaining number. In this case, the user may select which IDs to register, or each ID may have a priority level, and IDs stored in a descending order of priority.

5       Also, when there is an excess of a permission right, it is possible for on-vehicle device 602 to return the excess to AD server 600.

Moreover, although on-vehicle device 602 is described above as acquiring a permission right that includes the right  
10 of on-vehicle device 602, on-vehicle device 602 may register with AD server 600 as described in the above embodiment, and then acquire the right to notify CSI to on-vehicle devices 603 and 604.

15       (27) A plurality of authorized domains may be combined to form a single authorized domain.

As an example, the combining of AD\_E and AD\_F to form AD\_G is described below using Fig.51.

AD\_E and AD\_F are each structured from a single AD  
20 server and a plurality of client devices (not depicted). A maximum of "m" number of client devices is registerable in an AD server E in AD\_E, and devices registered in AD\_E each hold CSI\_E. Also, a maximum of "n" number of client devices is registerable in an AD server F in AD\_F, and devices

registered in AD\_F each hold CSI\_F.

AD\_G is formed from these two authorized domains. First, a device to be AD server G managing AD\_G is determined from out of AD servers E and F. At this time, the device to be  
5 AD server G may be determined based on processing capacity, priority levels and the like, or may be determined by a user. The AD server that is not AD server G is registered in AD\_G as a client device.

A maximum of "k" number of devices registerable in AD  
10 server G is set as "m", "n" or the mean of "m" and "n". Also, AD server G newly generates CSI\_G, authenticates each of the client devices, and transmits CSI\_G to devices that are successfully authenticated.

If the aggregate number of devices forming AD\_E and AD\_F  
15 exceeds the maximum "k", devices for registration are selected. In this case, AD server G may make the selection based on predetermined priority levels, or the user may make the selection.

Moreover, apart from newly forming a single authorized  
20 domain from two existing authorized domains, one authorized domain may be added to the other authorized domain. When AD\_F is added to AD\_E, devices within AD\_F are registered in AD server E as AD\_E client devices, and hold CSI\_E. In this case, if the number of client devices for registration exceeds

maximum "m", devices for registration may be selected as described above.

Moreover, "m", "n" and "k" are positive integers.

- 5 (28) A single authorized domain may be divided into a plurality of authorized domains.

As an example, the forming of AD\_I and AD\_J from AD\_H is described below using Fig.52.

- 10 AD\_H is structured from an AD server H and a plurality of client devices (not depicted).

AD server H is able to register "p" (positive integer) number of client devices, and devices registered in AD\_H each store CSI\_H.

- 15 AD server H, at a time of forming AD\_I and AD\_J, selects devices to be new AD servers I and J from client devices in AD\_H. At this time, devices having a high processing capability may be selected as AD servers, or the selection may be made based on the predetermined priority levels of devices. Also, a user may make the selection, or the selection  
20 may be made among client devices based on processing capability, priority levels and the like. Moreover, AD server H may form a new authorized domain as AD server I or AD server J.

After the division, client devices to belong to each

authorized domain are selected. At this time, AD servers I and J may make respective selections based on priority levels, or the user may make the selection.

AD servers I and J can each register a maximum of "p" number of client devices. Also, once the client devices of each authorized domain have been selected, AD server I generates CSI\_I and transmits the generated CSI\_I to selected client devices. Also, AD server J, in the same way, generates CSI\_J and transmits the generated CSI\_J to selected client devices.

Moreover, AD servers I and J may conduct authentication every time a client device is selected or at a time of transmitting newly generated CSI.

Also, apart from newly forming two authorized domains from a single authorized domain as described above, one new authorized domain may be formed from AD\_H, and client devices divided between the original AD\_H and the new authorized domain.

(29) When a client device cuts a power supply, the client device may remain registered in an AD server, and CSI temporality deleted.

In this case, once a client device is registered in an AD server, the AD server stores an ID of the client device,

and transmits CSI.

The client device, having stored the received CSI, is able to use contents as a device within the authorized domain managed by the AD server. The client device, on receipt of  
5 a power-OFF instruction, deletes the CSI and sets power off. At this time, the ID of the client device stored in the AD server is not deleted.

When the power supply of the client device is again set "on", the client device transmits the ID to the AD server.  
10 The AD server judges whether an ID matching the received ID exists among IDs stored therein, and again transmits the CSI to the client device without updating the registration information if judged that a matching ID exists.

Moreover, the CSI may also be temporarily deleted in  
15 the event of cable or radio communication being interrupted, and when communication is reestablished, the ID may again be transmitted and the CSI again acquired.

(30) Although in the above embodiment, authentication is  
20 conducted using CSI, the following authentication processing (a) to (c) may be supplemented.

(a) Authenticate that a client device is connected to the same in-house LAN as an AD server, using a code uniformly provided by a system, or a MAC address, an IP address or the

like. In this way, it becomes difficult to register the client device of another user/entity.

Also, when an AD server and a client device conduct radio communication, it may be authenticated that the client  
5 device is within range of the radio waves.

Also, when communication is possible between an AD server and a client device, authentication data may be transmitted from the AD server to the client device, and response data transmitted from the client device to the AD  
10 server. The AD server may clock the time period from transmission of the authentication data to reception of the response data, and if the clocked time is within a preset threshold, the client device may be authenticated as being located in-house.

15 Also, time-to-live (TTL) values may be set to be within the number of in-house routers, thus preventing the AD server from being able to communicate with out-house devices.

Also, it may be authenticated whether a client device is located in-house by judging whether the client device is  
20 connected to the same power source as the AD server.

(b) Preset a password in an AD server, and at a time of registering a client device, the user manually inputs a password into the client device. The client device transmits a registration request to the AD server that includes the

inputted password, and the AD server judges whether the received password included in the registration request matches the preset password.

Also, a plurality of passwords may be set, an example  
5 of which is each member of a family setting their own password. Also, an ID identifying a user may be combined with a password.

(c) Instead of a password as in (b) above, biometric information such as fingerprints, the iris, and the like may be used. In this way, it becomes possible for only a preset  
10 user to register a client device.

(31) An initial value held by a client device may be applied as described in (a) to (c) below.

(a) A client device holds a single initial value showing  
15 "not registered in AD server". When the client device registers with the AD server, the initial value is deactivated.

(b) A client device holds a plurality of initial values corresponding one-to-one with a plurality of AD servers. At  
20 a time of registering with one of the AD servers, authentication is conducted using an initial value corresponding to the AD server, and if successful and the client device is registered, the corresponding initial value is deactivated. Likewise, if the client device registers in



another of the AD servers, an initial value corresponding to the other AD server is deactivated.

Moreover, each initial value may be identified in correspondence with an identifier of a group.

5           (c) A client device holds a single initial value showing "not registered in any AD server". When the client device registers with an AD server, the initial value is deactivated.

10       (32) The present invention may be a method showing the above. Also, this method may be computer program realized by a computer, or a digital signal formed from the computer program.

Also, the present invention may be a flexible disk, a  
15   hard disk, a CD-ROM, an MO, a DVD, a DVD-ROM, a DVD-RAM, a BD (blu-ray disk), a semiconductor memory or similar computer-readable recording medium that stores the computer program or the digital signal. Also, the present invention may be the computer program or digital signal recorded onto  
20   such a recording medium.

Also, the present invention may be the computer program or the digital signal transmitted via a network or the like, representative examples of which include a telecommunication circuit, a radio or cable communication circuit, and the

Internet.

Also, the present invention may be a computer system that includes a microprocessor and a memory, the memory storing the computer program and the microprocessor  
5 operating in accordance with the computer program.

Also, by transferring the computer program or the digital signal, either recorded on the recording medium or via a network or the like, the present invention may be implemented by another independent computer system.

10

(33) The present invention may be any combination of the above embodiment and variations.

Although the present invention has been fully described  
15 by way of examples with reference to the accompanying drawings, it is to be noted that various changes and modifications will be apparent to those skilled in the art. Therefore, unless such changes and modifications depart from the scope of the present invention, they should be construed  
20 as being included therein.